NATIONAL HEATING GUIDE

Blue Book of the Industry

NATIONAL
RADIATOR
CORPORATION

PRICE CHANGE

EFFECTIVE OCTOBER 23, 1950

Attach This Notice to Cover of Trade Price Sheet HD-200 and HD-200-Revised
Dated August 14, 1950

ADD 10%

To All Prices in This Price Sheet Except Indirect Water Heaters and Automatic Controls

Vendors' Price Sheets Will Govern on Items Not of Our Manufacture

THE NATIONAL RADIATOR COMPANY

JOHNSTOWN, PENNSYLVANIA

Form No. ES-100.

Printed in U. S. A.

NATIONAL HEATING GUIDE

Blue Book of the Industry

NATIONAL
RADIATOR
CORPORATION

General Offices - Johnstown, Pa.

Serving . . .

The Heating Needs of a Nation

EMERGING constantly from eight great plants are steady streams of National products. Products in which science, skill, and unswerving standards are united to give to the world the latest and best in heating equipment.

Offered to the trade through distributing offices and warehouses located in leading cities, these products are backed by a quality of National service and cooperation that gives a new meaning to these terms.

With its outstanding products, and its helpful, intelligent service, The National Radiator Corporation competently and completely serves the heating needs of a Nation.

NATIONAL SALES AND SERVICE

National Service Through These Branch Offices, Plants and Warehouses

BALTIMORE, MD.	Office and Warehouse	2622 Matthews St.
BOSTON, MASS.	Office	93-97 Oliver St.
	Warehouse	Framingham, Mass.
BUFFALO, N. Y.	Office	259-265 Delaware Ave.
	Warehouse	Dunkirk, N. Y.
CHICAGO, ILL.	Office and Warehouse	2445 N. Keeler Ave.
	Plant	1111 E. 83rd St.
CINCINNATI, OHIO	Office and Warehouse	3530 Spring Grove Ave.
CLEVELAND, OHIO	Office and Warehouse	935 E. 63rd St.
DETROIT, MICH.	Office	Suite 903, Fisher Bldg.
DUNKIRK, N. Y.	Plant	Stelgeski St.
FRAMINGHAM, MASS.	Plant	Arlington St.
INDIANAPOLIS, IND.	Office and Warehouse	431 W. Georgia St.
JOHNSTOWN, PA.	Office	221 Central Ave.
	Plant	Bridge St.
	"	Central Ave.
MILWAUKEE, WIS.	Office and Warehouse	2003 St. Paul Ave.
NEW CASTLE, PA.	Plant	Cascade Park
NEW YORK, N. Y.	Office	55 W. 42nd St.
	Warehouses—	
		5 Commercial Avenue, Garden City, L. I.
		Bush Terminal, Bldg. No. 3, Brooklyn, N. Y.
		Lincoln Terminal, Bldg. No. 7, Kearny, N. J.
OMAHA, NEB.	Office and Warehouse	1101 Jackson St.
PHILADELPHIA, PA.	Office	508 Liberty Trust Bldg.
	Warehouses—	
		E. State St. & Whitehead Rd., Trenton, N. J.
		Front St. & Lebanon Valley R. R., Reading, Pa.
PITTSBURGH, PA.	Office	1509 Arrott Bldg.
	Warehouse	New Castle, Pa.
RICHMOND, VA.	Office and Warehouse	3032 Norfolk St.
ST. LOUIS, MO.	Office and Warehouse	1042 Central Industrial St.
TRENTON, N. J.	Plant	E. State St. & Whitehead Rd.
WASHINGTON, D. C.	Office and Warehouse	2205 5th St., N. E.

National Heating Accessories stocked at all warehouses.

INDEX

NATIONAL BONDED BOILERS

NATIONAL RADIATION

INDEX (continued)

NATIONAL HEATING ACCESSORIES

INDEX (continued)

NATIONAL ENGINEERING DATA

A New Force . . .
in the Selling of Heating Equipment

THE National Radiator Corporation realizes that the time has arrived when the heating trade is ready for a far reaching merchandising idea, which will allow its members to sell a Heating System, rather than boilers, pipes and radiators.

The time has arrived, in short, to sell National "*Made-to-Measure*" Heating Systems, scientifically designed to supply the latest and best in heating results.

National is the first to introduce such an unusual and original idea in the art of merchandising Heating Equipment. It is an idea that properly places the stress on results rather than on causes, and folks today are primarily interested in results.

With the National *"Made-to-Measure"* Heating Systems was born an entirely new conception of what home heating can mean in health and happiness. Not only do these systems bring economy, dependability, convenience, and protection, but they *provide warmth to fit each individual room.*

Back of this idea is scientific engineering data, prepared especially for National, by eminent heating authorities. These data eliminate many complicated calculations and facilitate quick and accurate determination of correct radiation, boiler and other heating equipment requirements for the heating contractor. The installation operations of the heating contractor are further simplified by the convenient form in which the data are presented.

This revolutionary, new National "*Made-to-Measure*" idea so advances the science of modern heating that it is destined to open new fields of interest, and become a mighty force in the new-day methods of merchandising heating equipment.

A Bond . . .

Guarantees National Boiler Performance and Quality

THE boiler properly has been called the heart of the heating system. For on the boiler alone rests the responsibility to economically convert fuel to heat, and set up a process of heat circulation to and through the room radiators. Conditions under which a boiler must perform its important tasks vary considerably and for this very reason the boiler should be selected with utmost care, both as regards character of design, and capacity. The first step to permanent satisfaction is the right boiler for the right job.

The bond, a miniature reproduction of which is shown on the following page, is issued by a strong financial institution with resources of over Thirty-Nine Million Dollars, ($39,000,000.00). It contains four distinct guaranteed stipulations as to the performance, manufacture, testing and replacement of defective parts. It is absolute assurance to you and your customers that the boiler will deliver in actual practice what the manufacturer claims for it.

The Fidelity and Casualty Company of New York

92 Liberty Street, New York, N. Y.

Resources in Excess of Thirty-Nine Million Dollars

Know All Men by These Presents That we, the National Radiator Corporation, a Delaware Corporation with offices in New York, N. Y., as Principal, and The Fidelity and Casualty Company of New York, a Corporation organized under the laws of the State of New York,

as Surety, are held and firmly bound for the period of one year from .... 19......,

to ....

of ....

for the faithful performance of the Agreements listed below,

Provided however that the obligation of The Fidelity and Casualty Company of New York as surety and guarantor hereunder for the faithful performance by the National Radiator Corporation of the agreements set forth herein shall not exceed the sum of

Blank Hundred and Blank Dollars

The Agreements apply to National Bonded Boiler No.............., purchased.................. 19......

from..................

and are as follows, to wit:

1. In the event that any or all of the following representations contained in paragraph (a) below are shown to be incorrect or untrue at any time during the period above mentioned, then, in that event, to furnish, without charge, a new boiler of the same type and capacity which meets the representations set forth.

(a) That the National Boiler covered by this Bond was manufactured and hydrostatically tested in accordance with the Code of the American Society of Mechanical Engineers covering the construction of Low Pressure Heating Boilers, and is so marked; also that all fittings and appliances furnished as standard equipment by the manufacturer are in accordance with the said Code;

2. In the event that an original manufacturing defect develops within one year from date of installation, then, in that event, to furnish a new replacement part, without charge, provided such defective part is returned to the nearest plant or warehouse of the National Radiator Corporation. (This does not cover breakage or damage due to rough handling or abuse.)

3. In the event that the boiler fails to deliver the capacity necessary to carry the direct cast iron radiation load published in the manufacturer's catalog current at the time of sale, and, provided the boiler has been installed under the manufacturer's specified requirements, is connected to a correctly installed system and chimney having proper draft, and is operated in accordance with the manufacturer's printed instructions; then, in that event, to furnish, without charge, additional boiler parts necessary to meet the required boiler capacity

NATIONAL RADIATOR CORPORATION

Number..................

By.................. For Vice-President

Date ....

The Fidelity and Casualty Company of New York

Countersigned by

.... Agent

By.................. Attorney

Form E. S. 23 R-3034-6-29-P&C

Facsimile of Surety Bond issued with each National Bonded Boiler

The bonds are issued in different denominations, and the amounts will fully cover the purchase price of the boiler, regardless of size.

In order to remove any uncertainty regarding the amount of direct cast iron radiation which each National Bonded Boiler is guaranteed to heat, we list herein net radiator loads under the heading "Bonded Direct Cast Iron Radiation." This makes the selection of the proper boiler size a sure and simple matter. An allowance for normal piping is included in the bonded load.

Each National Bonded Boiler is guaranteed to heat the full amount of direct cast iron radiation listed in its rating table when connected to a properly installed system, in accordance with specified requirements listed herein.

MANUFACTURER'S SPECIFIED REQUIREMENTS

1. *Determining Direct Cast Iron Radiation Requirements:* Reduce all required types of radiation surfaces to an equivalent direct cast iron radiation basis. This basis being that one square foot of direct cast iron steam radiation will emit 240 B.T.U. per hour, and that one square foot of hot water radiation will emit 150 B.T.U. per hour.

2. *Corrections Applying:* Under ordinary conditions, the following factors may be used to convert the following surfaces to an Equivalent Direct Cast Iron Radiation basis:

Direct—Indirect Radiation, multiply by 1.25
Indirect, multiply by........................ 1.5

Blast coils; use manufacturer's condensation chart and multiply condensation in pounds of steam per hour by........................ 4.0

Domestic Hot Water Supply. When coil in fire box is used, and small quantity of water is to be heated, multiply storage tank capacity in gallons—

for steam by.................. 2.0
for water by.................. 3.0

If large quantities of water are to be heated, or indirect heaters are connected to the boiler, the radiator load should be computed as outlined in the Engineering Section of the National Heating Guide, page 364 and page 371.

3. *Radiation Requirements:* The amount of radiation required to properly heat a building to the specified temperature is to be determined by using the method outlined in the National Heating Guide, current at the time the boiler is sold, or in accordance with the methods adopted by the Heating and Piping Contractors National Association, or the American Society of Heating and Ventilating Engineers, and in current use by them.

4. *Piping and Peak Load Allowances:* The published Direct Cast Iron Radiation Loads listed herein include allowances for heat losses from piping and peak

loads under ordinary conditions. If the actual surface in square feet of piping exceeds 25% of the Direct Cast Iron Radiation for steam, or 35% for water, additional allowances must be made for the extra surface. (See table in Engineering Section, Page 361 of the National Heating Guide showing the square feet of surface per lineal foot of pipe of various sizes.

5. *Draft:* The chimney to which the boiler is connected must be of recognized standard construction and dimensions, and provide sufficient draft to properly consume the required amount of fuel per hour.

6. *Fuel:* The Direct Cast Iron Radiation Loads listed herein are based upon the use of a free burning coal not smaller than nut size, and having a B.T.U. heat content per pound of at least 12,500. If coal having a less heat value is used, obviously more coal must be burned to get the same result, and more boiler capacity is required. Multiply the Equivalent Direct Cast Iron Radiation Load by the factor shown below, for coal having a heat value of less than 12,500 B.T.U.

Heat Value of Coal in B.T.U. per Pound	Factor
12,500	1.00
12,000	1.07
11,500	1.13
11,000	1.21
10,500	1.28
10,000	1.36
9,500	1.46
9,000	1.56
8,500	1.67

Example: Direct Cast Iron Radiation Load, 430 sq. ft; coal to be used has heat value of 10,500 B.T.U. The corresponding factor as shown on page 13 is 1.28. Multiply 430 by 1.28, equals 550. Select a boiler with a Bonded Direct Cast Iron Radiation Load of not less than 550 sq. ft.

7. *Oil Burners:* If an oil burner is used, the burner must be properly installed and have a minimum capacity to burn each hour, with proper combustion, a quantity of oil containing 480 B.T.U. for each square foot of steam radiation and 300 B.T.U. for each square foot of water radiation. Direct Cast Iron Radiation Ratings for oil burning boilers are listed separately.

8. *Cleaning:* Oil, grease and foreign matter must be removed from the boiler and system by proper methods as outlined in Erecting Instructions furnished with each boiler.

9. *Operation:* Instructions for coaling and proper operation are furnished with each boiler, and the boiler must be operated in accordance therewith in order to come under the terms of this guarantee.

NATIONAL BONDED BOILERS

National No. 2-S-6

NATIONAL Jacketed Boilers are carefully made and thoroughly tested under a hydrostatic pressure more than four times normal. This rigid test eliminates trouble from leaks and assures care-free operation.

The No. 2 Series illustrated above is made in five sizes and is bonded to heat from 200 to 560 square feet of steam radiation or from 330 to 930 square feet of water radiation. Complete data and dimensions are given on pages 20 and 21.

Excellent . . .

first impressions reinforced on acquaintance

ARCHITECT, engineer, heating contractor, user—all find in the National Jacketed Boiler common ground on which to meet; find many uncommon virtues to praise. Each boiler is designed in strict accord with the most advanced engineering principles. Ease of installation, economy of operation, and sound, dependable performance are the ends sought and attained.

Invariably the National Jacketed Boiler makes an excellent first impression, wins admirers at sight. Its splendid lines and balanced proportions, its attractive baked enamel finish, its harmoniously contrasting base and doors, set new standards of boiler beauty. This excellent first impression is reinforced on acquaintance with the unit's outstanding excellence in performance.

The accessories are of the highest quality. Those furnished as standard equipment on steam boilers include a sensitive all-metal, all-inclosed damper-regulator, that adjusts the drafts, maintaining a constant pressure automatically; a Bourdon-tube retard steam gauge, with water seal and non-glare dial; an A. S. M. E. standard pop safety valve; a water glass; two tri-cocks; and firing tools. Water equipment comprises an altitude gauge, thermometer, firing tools and a water temperature regulator, which automatically regulates the drafts.

National No. 2-S-6 Interior View

NOTE how the burning gases, after they leave the firebox, travel upward into the first flue gallery, then forward, up, and back through the second flue gallery. This double set of three flue galleries is formed by numerous water tubes, within which the water circulates very rapidly, absorbing the heat and rushing it up to the radiators. This construction makes the boiler especially well adapted for use with oil burners—a field in which it enjoys an enviable reputation.

Complete data and dimensions are given on pages 20 and 21.

Designed . . .

with care and so used with confidence

THE large fire box of the National Jacketed Boiler (its size is in striking contrast to those of similarly rated boilers) holds a heavy charge of fuel, making frequent attention unnecessary. Even with the fire box filled for an unusually long firing period, there is ample space between the top of the fuel and the crown sheet for proper and efficient combustion. This means that the gases distilled from the coal are burned at extremely high temperatures. If there is insufficient combustion space, the gases go up the chimney unconsumed; the coal is "burned" to ashes, but at a relatively low temperature, due to improper combustion of the gases.

The large cleanout doors at the top of the boiler expose all flue-ways for easy cleaning, and the boilers can, therefore, be operated at highest efficiency at all times.

Due to the scientific proportioning of the combustion chamber, arrangement of the heating surfaces and rapid circulation of the water within the boiler, National Jacketed Boilers are very rapid heaters. They have quick pick-up, a feature much appreciated when it is desired to quickly raise the temperature of the rooms, on cold winter mornings.

NATIONAL BONDED JACKETED SQUARE BOILERS

Series No. 2
Sizes and Ratings
For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney Size Inches	Chimney Height Feet
Steam								
2-S-4	400	200	1.5	131	2–2½″	2–2½″	8 x 8	30
2-S-5	575	290	2.0	175	2–2½″	2–2½″	8 x 8	30
2-S-6	750	380	2.5	219	2–2½″	2–2½″	8 x 8	30
2-S-7	925	470	3.0	262	2–2½″	2–2½″	8 x 12	35
2-S-8	1100	560	3.5	306	3–2½″	3–2½″	8 x 12	35
Water								
2-W-4	675	330	1.5	131	2–2½″	2–2½″	8 x 8	30
2-W-5	950	480	2.0	175	2–2½″	2–2½″	8 x 8	30
2-W-6	1250	630	2.5	219	2–2½″	2–2½″	8 x 8	30
2-W-7	1550	780	3.0	262	2–2½″	2–2½″	8 x 12	35
2-W-8	1850	930	3.5	305	3–2½″	3–2½″	8 x 12	35

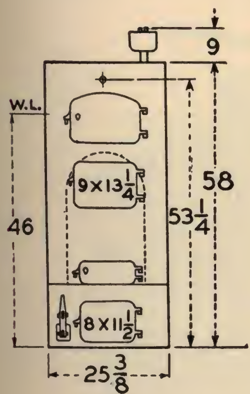
Standard Assembly of Boiler Sections

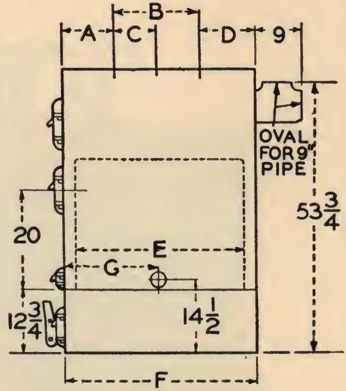
F—Front; I—Intermediate plain; U—Next to front uptake, plain; T°—Intermediate supply outlet, no return inlet; R°—Intermediate supply outlet, one return inlet on right side; B—Back, two return inlets.

Boiler Numbers		Arrangement of Sections 1	2	3	4	5	6	7	8	9	Shaking Grates
2-S-4	2-W-4	F	T°	T°	B						3
2-S-5	2-W-5	F	T°	I	T°	B					4
2-S-6	2-W-6	F	I	T°	I	T°	B				5
2-S-7	2-W-7	F	U	T°	I	T°	I	B			6
2-S-8	2-W-8	F	U	T°	I	R°	I	T°	B		7

Supply Outlet Tappings: (°) after key letter indicates section has supply outlet tapping. Center to center distance between sections is 4¼ inches.

Series No. 2 — Steam and Water Dimensions



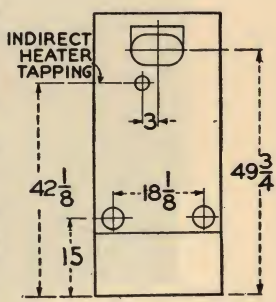


Measurements are subject to slight variations in assembly. Ash pit and foundation measurements are shown on page 32.

Supply Outlet Tappings: Two or more in top of intermediate sections. Letters A, B, C, and D refer to location of, and distance between, outlets.

Return Inlet Tappings: Two in rear of back section. Additional side inlet tapping in 8 section boilers.

Indirect External Water Heater Tapping: One 1½" tapping located in rear of back boiler section. Bosses for additional 1½" tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.



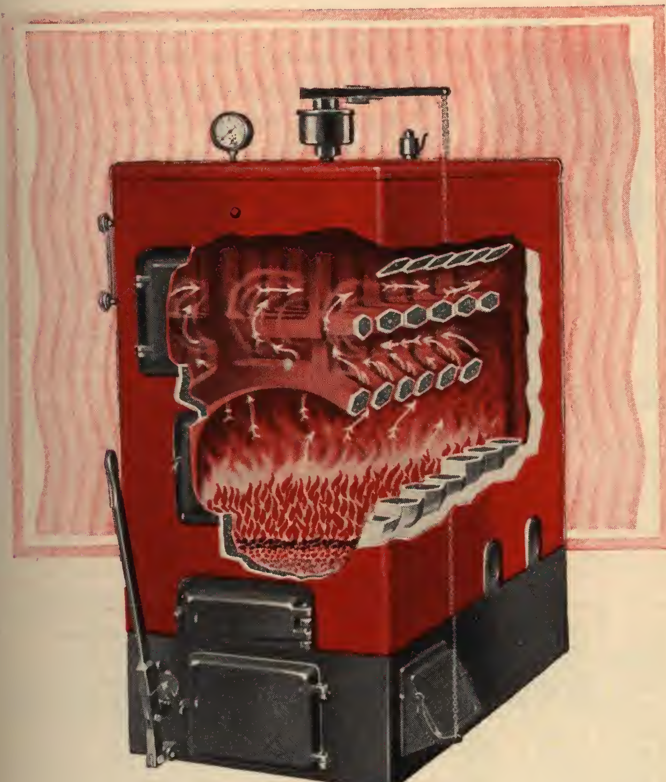
Boiler Number		A	B	C	D	E	F	G
2-S-4	2-W-4	6¼"	4¼"	....	6¼"	12¼"	17⅛"	...
2-S-5	2-W-5	6¼"	8½"	....	6¼"	16½"	21½"	...
2-S-6	2-W-6	10½"	8½"	....	6¼"	20¾"	25¾"	...
2-S-7	2-W-7	10½"	8½"	....	10½"	25 "	30 "	...
2-S-8	2-W-8	10½"	17 "	8½"	6¼"	29¼"	34¼"	19"

NATIONAL BONDED JACKETED SQUARE BOILERS

National No. 3-S-8

THE fine reputation of this boiler, built up over a period of many years, is due largely to its ability to burn with equal economy anthracite or bituminous coal, coke, oil, and gas.

This boiler is made in four sizes and is bonded to heat from 480 to 840 square feet of steam radiation or from 790 to 1390 square feet of water radiation. Complete data and dimensions are given on pages 24 and 25.



National No. 3-S-8 Interior View

THE water in this boiler is broken up into numerous small columns, which rapidly absorb the heat from the hot gases, as they swirl through the double set of three flue-ways, in a long, forward-and-back travel. This feature assures maximum heat absorption. It also admirably fits this unit for efficient oil burning.

Complete data and dimensions are given on pages 24 and 25.

Series No. 3—Sizes and Ratings

For Steam, Vapor and Hot Water

THE square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney	
							Area Inches	Height Feet
3-S-5	900	480	3.12	247	2-3″	2-3″	8 x 12	35
3-S-6	1,100	600	3.91	309	2-3″	2-3″	8 x 12	35
3-S-7	1,300	720	4.70	371	3-3″	4-3″	8 x 12	35
3-S-8	1,500	840	5.49	433	3-3″	4-3″	8 x 12	40

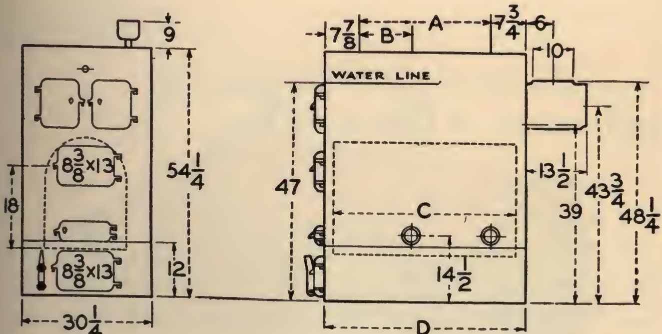
Water

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney	
							Area Inches	Height Feet
3-W-5	1,500	790	3.12	247	2-3″	2-3″	8 x 12	35
3-W-6	1,850	990	3.91	309	2-3″	2-3″	8 x 12	35
3-W-7	2,200	1,190	4.70	371	3-3″	4-3″	8 x 12	35
3-W-8	2,550	1,390	5.49	433	3-3″	4-3″	8 x 12	40

Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections. Distance from center of one section to center of section next to it is 5⅞ inches.

Return Inlet Tappings: One on each side of intermediate supply outlet section "R".

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.



Series No. 3—Steam and Water Dimensions

Boiler Numbers		A	B	C	D
3-S-5	3-W-5	11¾″	.....	23⅛″	27¾″
3-S-6	3-W-6	17⅝″	.....	29 ″	33½″
3-S-7	3-W-7	23½″	11¾″	34⅞″	39¼″
3-S-8	3-W-8	29⅜″	17⅝″	40¾″	45 ″

Measurements are subject to slight variations in assembly.
Ash Pit and foundation measurements are shown on page 32.

Standard Assembly of Boiler Sections

F—Front; I—Intermediate plain; T°—Intermediate supply outlet, no return inlets; R°—Intermediate supply outlet, 2 return inlets; B—Back, no return inlets.

Arrangement of Sections

Boiler Numbers		1	2	3	4	5	6	7	8	Shaking Grates
3-S-5	3-W-5	F	T°	I	R°	B				4
3-S-6	3-W-6	F	T°	I	I	R°	B			5
3-S-7	3-W-7	F	T°	I	R°	I	R°	B		6
3-S-8	3-W-8	F	T°	I	I	R°	I	R°	B	7

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 5⅞ inches.
Grate bars are interchangeable

National No. 4-S-8

THE dependability, efficiency, and heating qualities of this boiler have been demonstrated in thousands of installations throughout the country. It ably meets the demand for a jacketed boiler for large residences, and small apartment buildings.

The No. 4 Series illustrated is made in five sizes and is bonded to heat from 700 to 1400 square feet of steam radiation and from 1150 to 2310 square feet of water radiation.

Quality . . .

hidden from inspection, but apparent in operation

THE jacket of the National Jacketed Boiler is assembled without a single bolt or screw. An ingenius lock-lap joint permits quick setup, affords permanent rigidity. The material is 18-gauge open hearth steel, "two-pass" cold rolled, deoxidized to remove all scale, and then patent leveled to eliminate buckling. The successive coats of enamel are baked on, giving a beautiful vitreous-like finish easily cleaned, and resistant to dirt, wear, and time.

The openings in the jacket, and the tappings in the boiler, are in proper alignment. This makes the attachment of the trimmings simple and easy.

Every crevice between the sides, and the top, of the boiler and its jacket is filled with rock wool insulation, shredded and blown. Because of this process, the material is very finely divided, and a maximum number of "voids" or dead air spaces are established. It is these voids, *and not the material itself,* that insulates. Rock wool was chosen after exhaustive tests. Sheet types of insulation, while less costly, leave "flue spaces" for air circulation between jacket and boiler, causing loss of heat and decreased efficiency.

NATIONAL BONDED JACKETED SQUARE BOILERS

National No. 4-S-7 Interior View

IN this boiler the hot gases rise through the arched crown sheet, which provides a large amount of prime heating surface. They are then drawn to the rear of the boiler. Here they pass up into the two side flues, through which they travel to the front of the boiler and then back again through the central flue, which connects with the smoke outlet. This exceptionally long fire travel ($2\frac{1}{2}$ times the length of the boiler) enables this boiler to burn any fuel—coal, coke, oil or gas—with gratifying efficiency.

Complete data and dimensions on pages 30 and 31.

Satisfaction . . .

complete and lasting, is assured

MINOR refinements contribute much to the appeal of National Jacketed Boilers. The draft door is of the butterfly-balanced type, offering sure, delicate control when operated either manually or automatically. The three-position shaking mechanism locks the grates at normal, allows restricted motion, or—if desired—the dumping of the fire. Grate lugs are cast on the base panels so that, in case of breakage through abuse, only a base panel, and not a boiler section, need be replaced. A skimmer tapping is placed at the water line for easy cleaning of oil from the water surface.

Steam boilers are provided with suitable tappings for the connection of external indirect water heaters, for supplying domestic hot water. (See page 269 for a description of various types of indirect heaters).

The National Jacketed Boiler is a remarkable contribution to domestic heating equipment. To the merit of attractiveness it adds efficiency, economy, convenience, quick pick-up, and a dependability that makes it a lifetime investment, fits it to be a true and trusted heart of the heating system.

Series No. 4 — Sizes and Ratings

For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam

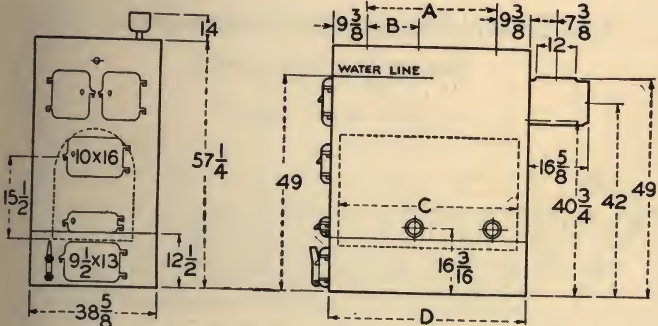
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney	
							Area Inches	Height Feet
4-S-5	1,475	700	4.78	324	2-4″	2-4″	12 x 12	30
4-S-6	1,800	875	5.95	403	2-4″	2-4″	12 x 12	35
4-S-7	2,125	1,050	7.12	482	3-4″	4-4″	12 x 12	35
4-S-8	2,450	1,225	8.29	561	3-4″	4-4″	12 x 12	40
4-S-9	2,775	1,400	9.46	640	3-4″	4-4″	12 x 16	45

Water

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney	
							Area Inches	Height Feet
4-W-5	2,400	1,150	4.78	324	2-4″	2-4″	12 x 12	30
4-W-6	2,900	1,440	5.95	403	2-4″	2-4″	12 x 12	35
4-W-7	3,500	1,730	7.12	482	3-4″	4-4″	12 x 12	35
4-W-8	4,000	2,020	8.29	561	3-4″	4-4″	12 x 12	40
4-W-9	4,500	2,310	9.46	640	3-4″	4-4″	12 x 16	45

Supply Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections. Distance from center of one section to center of section next to it 6⅞ inches.

Return Inlet Tappings: One on each side of next-to-back section "RU". Additional inlet tappings on each side of intermediate outlet section "R" in 7, 8, and 9 section boilers.



Series No. 4—Steam and Water Dimensions

Boiler Numbers		A	B	C	D
4-S-5	4-W-5	13¾"	.....	28⅛"	33¼"
4-S-6	4-W-6	20⅝"	.....	35 "	40⅛"
4-S-7	4-W-7	27½"	13¾"	42⅞"	47 "
4-S-8	4-W-8	34⅜"	13¾"	49¾"	53⅞"
4-S-9	4-W-9	41¼"	20⅝"	56⅝"	60¾

Measurements are subject to slight variations in assembly.
Ash Pit and foundation measurements are shown on page 32.
Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

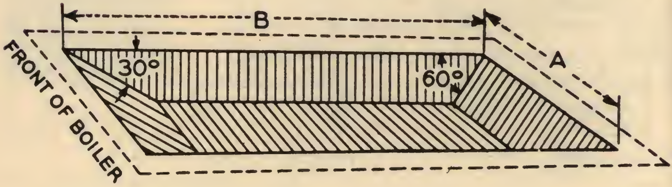
Standard Assembly of Boiler Sections

F—Front; I—Intermediate plain; T°—Intermediate supply outlet, no return inlet; R°—Intermediate supply outlet, and 2 return inlets; RU°—Half uptake next to back, supply outlet and 2 return inlets; B—Back, no returns.

Boiler Numbers		Arrangement of Sections									Shaking Grates	
		1	2	3	4	5	6	7	8	9	Front	Back
4-S-5	4-W-5	F	T°	I	RU°	B					2	2
4-S-6	4-W-6	F	T°	I	I	RU°	B				3	2
4-S-7	4-W-7	F	T°	I	R°	I	RU°	B			3	3
4-S-8	4-W-8	F	T°	I	R°	I	I	RU°	B		4	3
4-S-9	4-W-9	F	T°	I	I	R°	I	I	RU°	B	4	4

(°) After key letter indicates section has supply outlet tapping.
Center to center distance between sections is 6⅞ inches.
Grate bars are interchangeable.

Ash Pit and Foundation Recommendations
Series No. 2, 3, and 4



WARPED and burned grate bars are, in practically all cases, due to ashes accumulating until they come in contact with the grates. National grate bars are scientifically designed with ample cooling area, and will last indefinitely if ashes are kept away. As an added factor of safety in operating the boilers, it is recommended that an ash pit be constructed. The sketch above shows the construction. When the basement floor is not yet laid, the pit should be surrounded by a foundation 8 to 10 inches wide so that setting up the boiler need not be delayed.

Tables giving complete dimensions for proper pitting under National Jacketed Square Boilers are given on the opposite page.

Ash Pit and Foundation Measurements

Series No. 2
Steam and Water

Boiler Numbers		A	B	Depth of Pit
2-S-4	2-W-4	15″	13″	8″
2-S-5	2-W-5	15″	17¼″	8″
2-S-6	2-W-6	15″	21½″	8″
2-S-7	2-W-7	15″	25¾″	8″
2-S-8	2-W-8	15″	30″	8″

Series No. 3
Steam and Water

Boiler Numbers		A	B	Depth of Pit
3-S-5	3-W-5	17″	25″	10″
3-S-6	3-W-6	17″	30¾″	10″
3-S-7	3-W-7	17″	36½″	10″
3-S-8	3-W-8	17″	42¼″	10″

Series No. 4
Steam and Water

Boiler Numbers		A	B	Depth of Pit
4-S-5	4-W-5	22½″	30″	10″
4-S-6	4-W-6	22½″	36¾″	10″
4-S-7	4-W-7	22½″	43¾″	10″
4-S-8	4-W-8	22½″	50½″	10″
4-S-9	4-W-9	22½″	57½″	10″

NOTE: When the basement floor is not yet laid, surround the pit with a foundation 8 to 10 inches wide. These measurements refer to sketch on opposite page.

National Crimson Flame Boiler

THE rich warm color of the Crimson Flame Boiler is a vivid promise of the flood of friendly warmth which it will furnish for the home—a promise that is abundantly fulfilled. The boiler is furnished for steam, hot water and vapor systems, in a range of sizes suitable for any ordinary home application. Complete data and dimensions are shown on pages 40 and 41.

Warmth . . .

Vividly promised, Honestly delivered

WITH sterling worth that has won the esteem of users—with simplified, scientific design that heating experts praise—the National Crimson Flame meets the requirements of those who seek a touch of color in the basement and a flood of friendly warmth in the home.

The Crimson Flame can be completely assembled easily and quickly. The jacket is made of open hearth steel, "two-pass" cold rolled, deoxidized to remove all scale, and patent leveled to eliminate buckling. The successive coats of striking crimson enamel are baked on, giving a beautiful vitreous-like finish that is easily cleaned, and that resists dirt, wear, and time.

The boiler is snugly encased in a blanket of rock wool insulation on wire mesh, which prevents the dispersion of heat, thereby increasing the effective heating output of the boiler.

The Crimson Flame, in addition to the striking attractiveness conferred by its beautiful colored jacket, has a background in design which assures lasting satisfaction. Its moderate price is made possible because of mass production, and attendant manufacturing economies.

National Crimson Flame—Interior View

THE flames play against the bottom of the section above the fire box, then pass through water-surrounded ports of scientifically proportioned area, and "mushroom" out over the entire bottom of the section above, on their course toward the smoke stack. This process continues till the gases, their temperature reduced to a minimum, reach the chimney.

Straight Talk . . .

on Zig-Zag Fire Travel

THE Fire Travel in the National "Crimson Flame" is much longer than the linear distance between fire pot and smoke outlet would indicate. The zig-zag path of the hot gases carries them back and forth between ports, promoting rapid heat transfer, and a consequent increase in boiler efficiency.

Water legs on each side of the fire pot contribute to rapid water circulation, which means quick pick-up—a highly appreciated feature on cold mornings, when it is desired to raise the temperature fifteen or twenty degrees in a short time. In the steam boiler, the steam liberating area is large, giving a heavy overload capacity without danger of the water leaving the boiler.

The sectionalized design of the boiler has two outstanding advantages. It effectively takes up the expansion and contraction occasioned by the rapid changes in temperature within the boiler; and if through accident the boiler should be broken, it makes repair merely a matter of procuring and installing one small section—a comparatively inexpensive and simple proposition.

Styled . . .
for beauty
engineered for efficiency

NATIONAL Crimson Flame Boilers are designed to perform efficiently with domestic sizes of anthracite, bituminous coal, and coke. They can be converted on the job to meet the individual requirements of the fuel selected. The design of the grate and heating surface; the scientific size and shape of the combustion chamber; the serpentine fire travel; the properly proportioned waterways, and the balanced system of air intake and damper control, all unite to deliver a heating service eminently satisfactory because of maximum heating results from minimum fuel consumption.

The sensitive all-inclosed, all-metal damper regulator (furnished as standard equipment on the steam boiler) opens and closes the drafts automatically. Other equipment comprises a Bourdon-tube retard steam gauge; a gauge glass; tri-cocks; and firing tools. On the water boiler, a water temperature regulator, an altitude gauge, and a thermometer, are provided. Years of experience have demonstrated these accessories to be the best of their kind.

The boilers are shipped knocked-down, facilitating transportation to the job, and are easily and quickly assembled to form a perfect, dependable operating unit.

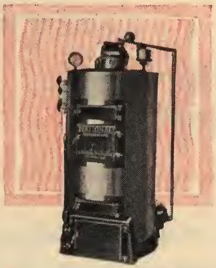
Achievement . . .

is the aim — not just a "job"

THE metal used in the National Crimson Flame is subjected to rigid analysis to assure conformation to the stringent National standards. Each section is tested on special machines, under pressure more than four times as great as the boiler will ordinarily be called upon to carry in actual operation. All machining is done to narrow limits, with permitted tolerances unbelievably small—a point that explains the ease with which National Boilers may be assembled on the job.

The grate mechanism is of the convenient three-position type; locking at normal, permitting restricted motion, or—if desired—the dumping of the fire. The grate is made to the full size of the fire-box; air space is proportioned to give uniform distribution over the entire surface, and the bar bottoms have adequate cooling surface to guard against burn-outs.

The pride of the National Radiator Corporation in its products, and its integrity in all dealings, are the user's best guarantees of complete satisfaction. To this integrity is added the accumulated knowledge and experience of the six long-established companies that formed the corporation, which make National Products the latest and best in heating equipment.



Sizes and Ratings

For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

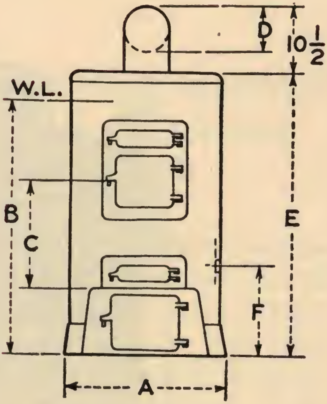
Steam

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney Size Inches	Chimney Height Feet
S-17	350	175	1.52	106	2–2½″	2–2½″	8 x 8	30
S-20	500	275	2.01	159	2–2½″	2–2½″	8 x 8	30
S-21	550	300	2.01	159	2–2½″	2–2½″	8 x 8	35
S-23	775	375	2.67	213	2–3″	2–3″	8 x 12	35

Water

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney Size Inches	Chimney Height Feet
W-17	600	285	1.52	106	2–2½″	2–2½″	8 x 8	30
W-20	850	455	2.01	159	2–2½″	2–2½″	8 x 8	30
W-21	925	495	2.01	159	2–2½″	2–2½″	8 x 8	35
W-23	1300	620	2.67	213	2–3″	2–3″	8 x 12	35

Indirect External Water Heater Tapping: One 1½ inch tapping located in left hand side of dome section.



Fire and Ash Pit Door Dimensions

Boiler Number	Dimensions—Inches	
	Fire Door	Ash Pit Door
17	9 x 10¾	9⅛ x 13
20	9 x 11	9 x 13
21	9 x 11	9 x 13
23	8⅞ x 13	9 x 13

Crimson Flame
Steam and Water Dimensions
Steam

Boiler Number	A	B	C	D	E	F
S-17	25¾″	41½″	18″	7″	47⅝″	14¼″
S-20	30¾″	45″	20″	8″	52¾″	14½″
S-21	30¾″	50″	20″	8″	57¾″	14½″
S-23	33¾″	45″	20″	8″	52¾″	14½″

Water

W-17	25¾″	.....	18″	7″	43½″	14¼″
W-20	30¾″	.....	20″	8″	46½″	14½″
W-21	30¾″	.....	20″	8″	51½″	14½″
W-23	33¾″	.....	20″	8″	46½″	14½″

Measurements are subject to slight variations in assembly.
Dimension "B" is height of water line.

National No. S-23-5

THIS boiler makes a powerful appeal to all seeking a business-like efficient heating unit, free of frills, but full of "go." A total of eighteen sizes, covering 6 grate diameters, provide for an extremely wide variety of applications. The boilers are bonded to heat from 175 to 925 square feet of steam radiation, and 285 to 1530 feet of water radiation.

Tributes . . .

Engineering approval
Popular acceptance

NATIONAL Round Boilers are designed to perform efficiently with all types of fuel; domestic sizes of anthracite and bituminous coal, oil, gas, and coke. They can be converted on the job to meet the individual requirements of the fuel selected. The design of the grate and heating surface; the scientific size and shape of the combustion chamber; the serpentine fire travel; the properly proportioned waterways, and the balanced system of air intake and damper control, all unite to deliver a heating service eminently satisfactory because of maximum heating results from minimum fuel consumption.

The sensitive inclosed, all-metal damper regulator (furnished as standard equipment on the steam boiler) opens and closes the drafts automatically. Other equipment comprises a Bourdon-tube retard steam gauge; a gauge glass; tri-cocks; and firing tools. Years of experience have proven these accessories to be the best of their kind. Accessories for the water boiler are furnished on order.

The boilers are shipped knocked-down, facilitating transportation to the job, and are easily and quickly assembled to form a perfect, dependable operating unit.

National No. S-23-5 Interior View

THE National Round Boiler is noted for its generous sized firepot that holds a charge of fuel sufficient for many hours. The unusual depth provides ample combustion space above the fuel bed for the efficient burning of the gases. The long, zig-zag fire travel, which promotes maximum heat transfer, is graphically shown.

Efficiency . . .

Long fire travel's a short cut to it

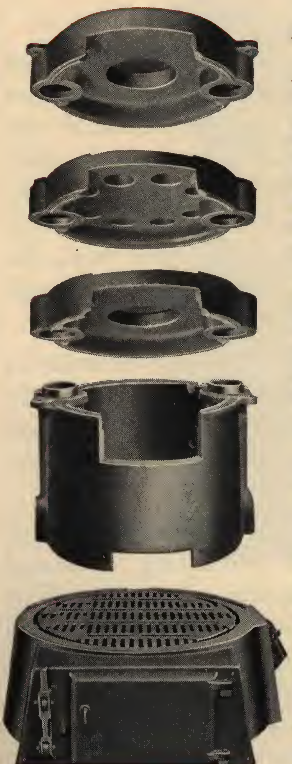
IN National Round Boilers, the flames play against the crown sheet section above the fire-box, then pass through water-surrounded ports, and "mushroom" out over the entire bottom of the section above, in their course to its openings. This continues till the gases, their temperature reduced to a minimum, reach the stack. Though the apparent travel is comparatively short, the zig-zag path of the gases is relatively long. Increased boiler efficiency arises from this factor.

Water legs on each side of the fire-box contribute to rapid water circulation, which means quick pick-up. In the steam boiler, the steam liberating area is large, giving a heavy overload capacity without danger of the water leaving the boiler.

The grate mechanism is of the convenient three-position type; locking at normal, permitting restricted motion, or—if desired—the dumping of the fire. The grate is made to the full size of the fire-box; air space is proportioned to give uniform distribution over the entire surface, and the bar bottoms have adequate cooling surface to guard against burn-outs.

National . . .

Acceptance—Sectional Design



THIS illustration shows the sectional arrangement of National Round Boilers. The method of producing the serpentine fire travel by means of zig-zag flue openings is graphically illustrated. The sectionalized design of the boiler has several outstanding advantages.

It facilitates handling on the job.

It effectively takes up the expansion and contraction occasioned by the rapid changes in temperature within the boiler.

Then if, through accident, the boiler should be broken, it makes repair merely a matter of procuring and installing one small section—a comparatively inexpensive and simple proposition.

Flat grates are regular equipment on this boiler. Triangular grates will be furnished on special order.

Precision . . .

Raises the Standards of Service

THE metal used in National Round Boilers is subjected to rigid analysis to assure conformation to the stringent National standards. Each section is tested on special machines, under pressures more than four times as great as the boiler will ordinarily be called upon to carry in actual operation. All machining is done to narrow limits, with permitted tolerances unbelievably small—a point that explains the ease with which National Boilers may be assembled on the job.

The pride of the National Radiator Corporation in its products, and its integrity in all dealings are the user's best guarantees of complete satisfaction. To this integrity is added the accumulated knowledge and experience of the six long-established companies that formed the corporation, which make National Products the latest and best in heating equipment.

NATIONAL BONDED ROUND BOILERS

Sizes and Ratings
For Steam and Vapor

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam

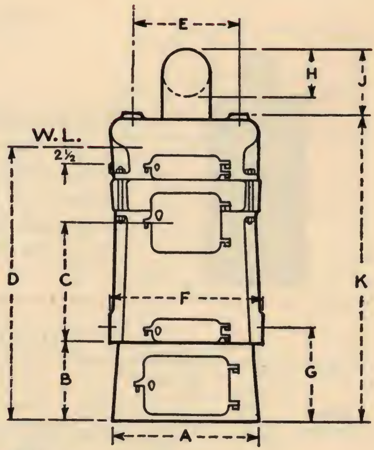
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	‡ Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney	
							Area Inches	Height Feet
S-17-4	350	175	1.52	106	2-2½"	2-2½"	8 x8	30
S-17-5	400	195	1.52	106	2-2½"	2-2½"	8 x 8	30
S-17-6	450	215	1.52	106	2-2½"	2-2½"	8 x 8	35
S-20-4	500	275	2.01	159	2-2½"	2-2½"	8 x 8	30
S-20-5	550	300	2.01	159	2-2½"	2-2½"	8 x 8	35
S-20-6	600	325	2.01	159	2-2½"	2-2½"	8 x 12	35
S-23-4	775	375	2.67	213	2-3"	2-3"	8 x 12	35
S-23-5	825	410	2.67	213	2-3"	2-3"	8 x 12	35
S-23-6	875	445	2.67	213	2-3"	2-3"	8 x 12	40
S-26-4	950	475	3.62	291	2-3"	2-3"	8 x 12	35
S-26-5	1,025	525	3.62	291	2-3"	2-3"	8 x 12	40
S-26-6	1,100	575	3.62	291	2-3"	2-3"	12 x 12	40
S-29-4	1,200	600	4.35	349	2-4"	2-4"	12 x 12	35
S-29-5	1,300	675	4.35	349	2-4"	2-4"	12 x 12	40
S-29-6	1,400	725	4.35	349	2-4"	2-4"	12 x 12	45
S-32-4	1,500	750	5.41	399	2-4"	2-4"	12 x 12	40
S-32-5	1,600	850	5.41	399	2-4"	2-4"	12 x 12	40
S-32-6	1,700	925	5.41	399	2-4"	2-4"	12 x 12	45

‡ Hard coal capacity to center of fire door based on 52.5 pds. per cu. ft.

Fire and Ash-Pit Door Dimensions

Boiler Number	Dimensions—Inches	
	Fire-Door	Ash-Pit Door
17	9 x 10¾	9⅛ x 13
20	9 x 11	9 x 13
23	8⅞ x 13	9 x 13
26	9 x 13	9 x 15
29	9⅞ x 15	9 x 15
32	10 x 15	9 x 15

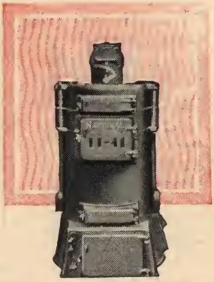
Indirect External Water Heater Tapping: One—1½ inch tapping located in left hand side of dome section, 2½ inches below water line.



Steam Dimensions

Boiler Number	A	B	C	D	E	F	G	H	J	K
S-17-4	22″	12″	18″	41½″	16⅛″	23¼″	14¼″	7″	10″	46½″
S-17-5	22″	12″	18″	46 ″	16⅛″	23¼″	14¼″	7″	10″	51 ″
S-17-6	22″	12″	18″	50½″	16⅛″	23¼″	14¼″	7″	10″	55½″
S-20-4	28½″	12″	20″	45″	19¼″	26½″	14½″	8″	10″	51½″
S-20-5	28½″	12″	20″	50″	19¼″	26½″	14½″	8″	10″	56½″
S-20-6	28½″	12″	20″	55″	19¼″	26½″	14½″	8″	10″	61½″
S-23-4	31⅜″	12¼″	20″	45″	22¼″	29″	14½″	8″	10″	51½″
S-23-5	31⅜″	12¼″	20″	50″	22¼″	29″	14½″	8″	10″	56½″
S-23-6	31⅜″	12¼″	20″	55″	22¼″	29″	14½″	8″	10″	61½″
S-26-4	34½″	12¼″	20″	45″	24¾″	32¾″	15″	10″	12″	51½″
S-26-5	34½″	12¼″	20″	50″	24¾″	32¾″	15″	10″	12″	56½″
S-26-6	34½″	12¼″	20″	55″	24¾″	32¾″	15″	10″	12″	61½″
S-29-4	37½″	12¼″	21¼″	46″	26¾″	35¾″	15½″	10″	12″	52½″
S-29-5	37½″	12¼″	21¼″	51″	26¾″	35¾″	15½″	10″	12″	57½″
S-29-6	37½″	12¼″	21¼″	56″	26¾″	35¾″	15½″	10″	12″	62½″
S-32-4	40⅜″	12½″	21¼″	46″	26¾″	39¾″	15½″	10″	12″	52½″
S-32-5	40⅜″	12½″	21¼″	51″	26¾″	39¾″	15½″	10″	12″	57½″
S-32-6	40⅜″	12½″	21¼″	56″	26¾″	39¾″	15½″	10″	12″	62½″

Flat grates regularly furnished.
When triangular grates are used add 2¼ inches to measurements B, D, G and K.
Dimension "D" is height of water line.



Sizes and Ratings

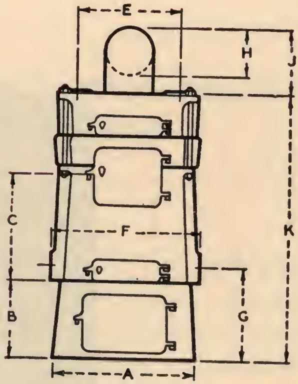
For Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Water

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	‡ Fuel Capacity Pds.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney	
							Area Inches	Height Feet
W-17-4	600	285	1.52	106	2-2½″	2-2½″	8 x 8	30
W-17-5	675	320	1.52	106	2-2½″	2-2½″	8 x 8	30
W-17-6	750	355	1.52	106	2-2½″	2-2½″	8 x 8	35
W-20-4	850	455	2.01	159	2-2½″	2-2½″	8 x 8	30
W-20-5	925	495	2.01	159	2-2½″	2-2½″	8 x 8	35
W-20-6	1,000	535	2.01	159	2-2½″	2-2½″	8 x 12	35
W-23-4	1,300	620	2.67	213	2-3″	2-3″	8 x 12	35
W-23-5	1,375	675	2.67	213	2-3″	2-3″	8 x 12	35
W-23-6	1,450	730	2.67	213	2-3″	2-3″	8 x 12	40
W-26-4	1,575	785	3.62	291	2-3″	2-3″	8 x 12	35
W-26-5	1,700	865	3.62	291	2-3″	2-3″	8 x 12	40
W-26-6	1,825	945	3.62	291	2-3″	2-3″	12 x 12	40
W-29-4	1,975	990	4.35	349	2-4″	2-4″	12 x 12	35
W-29-5	2,150	1,115	4.35	349	2-4″	2-4″	12 x 12	40
W-29-6	2,325	1,195	4.35	349	2-4″	2-4″	12 x 12	45
W-32-4	2,475	1,240	5.41	399	2-4″	2-4″	12 x 12	40
W-32-5	2,650	1,400	5.41	399	2-4″	2-4″	12 x 12	40
W-32-6	2,825	1,530	5.41	399	2-4″	2-4″	12 x 12	45

‡ Hard coal capacity to center of fire door based on 52.5 pds. per cu. ft.



Fire and Ash Pit Door Dimensions

Boiler Number	Dimensions—Inches	
	Fire Door	Ash Pit Door
17	9 x 10¾	9⅛ x 13
20	9 x 11	9 x 13
23	8⅞ x 13	9 x 13
26	9 x 13	9 x 15
29	9⅞ x 15	9 x 15
32	10 x 15	9 x 15

Hot Water Dimensions

Boiler Number	A	B	C	E	F	G	H	J	K
W-17-4	22″	12″	18″	16⅛″	23¼″	14¼″	7″	10″	42⅜″
W-17-5	22″	12″	18″	16⅛″	23¼″	14¼″	7″	10″	46¾″
W-17-6	22″	12″	18″	16⅛″	23¼″	14¼″	7″	10″	51⅛″
W-20-4	28½″	12″	20″	19¼″	26½″	14½″	8″	10″	46¾″
W-20-5	28½″	12″	20″	19¼″	26½″	14½″	8″	10″	51¾″
W-20-6	28½″	12″	20″	19¼″	26½″	14½″	8″	10″	56¾″
W-23-4	31⅜″	12¼″	20″	22¼″	29″	14½″	8″	10″	45⅜″
W-23-5	31⅜″	12¼″	20″	22¼″	29″	14½″	8″	10″	50⅜″
W-23-6	31⅜″	12¼″	20″	22¼″	29″	14½″	8″	10″	55⅜″
W-26-4	34½″	12¼″	20″	24¾″	32¾″	15″	10″	12″	45¾″
W-26-5	34½″	12¼″	20″	24¾″	32¾″	15″	10″	12″	50¾″
W-26-6	34½″	12¼″	20″	24¾″	32¾″	15″	10″	12″	55¾″
W-29-4	37½″	12¼″	21¼″	26¾″	35¾″	15½″	10″	12″	46¾″
W-29-5	37½″	12¼″	21¼″	26¾″	35¾″	15½″	10″	12″	51¾″
W-29-6	37½″	12¼″	21¼″	26¾″	35¾″	15½″	10″	12″	56¾″
W-32-4	40⅜″	12½″	21¼″	26¾″	39¾″	15½″	10″	12″	46¾″
W-32-5	40⅜″	12½″	21¼″	26¾″	39¾″	15½″	10″	12″	51¾″
W-32-6	40⅜″	12½″	21¼″	26¾″	39¾″	15½″	10″	12″	56¾″

Flat grates regularly furnished.

When triangular grates are used add 2¼ inches to measurements B, G, and K.

NATIONAL BONDED CONTENTO BOILERS

National Contento No. 6-W

IN any small home or small building where space, expense, or the absence of a basement prevents locating the boiler in the basement, Contento finds its field. Compact and attractive, economical to install and to operate, it efficiently burns hard coal, soft coal, or coke, brings a maximum of comfort, with a minimum of bother.

Contento . . .

Brings contentment to the Home

THE Contento Water Boiler brings to the old house, now heated with stoves; the small house, where a large heating plant is not justified; and to the house without a basement, the opportunity to have economical, desirable radiator heat, at a small investment, and at a small operating expense.

Thousands of users heartily endorse Contento, for it has given them cleanliness, convenience, and comfort in their home heating. From every standpoint, Contento is a fit companion of the other renowned units in the National Line.

While the price is surprisingly low, the units are designed and built with the same attention to detail found in all National manufacturing operations. Large production, and exceptional plant efficiency, make the reasonable price possible.

Firing tools are furnished on the Contento Water Boiler, but no trimmings are provided. If they are desired, full descriptions may be found in the accessory section.

National Contento No. 6-W Interior View

THE flames in Contento are not permitted to progress unhampered to the stack, carrying with them valuable heat units. They must travel a long path, past the water filled sections, and give up their heat to warm the home.

Duplicating . . .

large boiler standards in smaller boiler sizes

CONTENTO is a small unit—but retains in detail the features that make the larger National Boilers outstandingly efficient.

The flames rise, playing against wings on the side water legs, and against the crown sheet at the top. Together, these provide a large amount of "prime," or direct, heating surface. The flames then pass through ports between the sections, into the two side flues, progress—through passages entirely surrounded by water—to the front of the boiler, then to the back through the central flue. Fire travel is thus one and one-half times the length of the boiler—an adequate distance to permit a maximum of the heat in the gases to be absorbed by the water, and so transmitted to the radiators.

The fire-box is deep, and of sufficient capacity to permit heavy fuel charges. This not only makes the fuel burn more efficiently, but decreases the amount of attention required. Grates are geared together so one shaking cleans the entire fire. The ash pan is removable.

Made to the same rigid standards as the large boilers, Contento has, within its field, the same praiseworthy ability to provide a constant flow of healthful warmth, the same capacity to assure complete and permanent satisfaction.

Sizes and Ratings

For Hot Water

THE square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Sq. Ft.	* Bonded Direct C.I. Radiation Sq. Ft.	** Radiating Value Sq. Ft.	Grate Area Sq. Ft.	Fuel Capacity Pounds	Chimney	
						Area Inches	Height Feet
4-W	400	225	50	.90	70	8 x 8	25
5-W	535	305	60	1.22	90	8 x 8	25
6-W	670	385	70	1.54	115	8 x 8	30
7-W	825	465	80	1.86	140	8 x 8	30
8-W	990	545	90	2.18	165	8 x 8	35

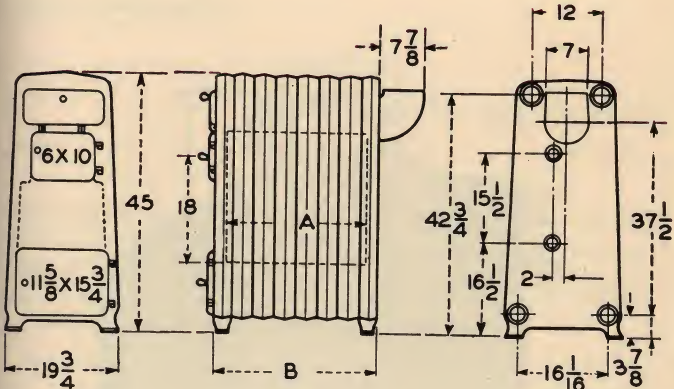
*Square feet of direct cast iron radiation boiler will carry when installed on same floor level with radiators. When installed in basement reduce the bonded load 20% to allow for piping.

**Radiating value in square feet of radiation of boiler, tank and piping.

Tappings: 2-2″ outlets and 2-2″ inlets located in rear of back section.

These boilers are shipped assembled in one piece.

Ash pan and firing tools are furnished with each boiler.



Water Dimensions

Boiler Number	A	B
4-W	10 ¼″	13 ¼″
5-W	13 13/16″	16 13/16″
6-W	17 ⅜″	20 ⅜″
7-W	20 15/16″	23 15/16″
8-W	24 ½″	27 ½″

Measurements are subject to slight variations in assembly.

National No. 20-8-S

THIS boiler enjoys an enviable reputation for service, honestly earned in many years of dependable heating performance. It is made in four sizes, and is bonded to heat from 480 to 840 square feet of steam radiation, and from 790 to 1390 square feet of water radiation.

Universally . . .

used—
universally advocated

STANDARD for almost twenty years, the Novus Boiler has served in all sorts of heating applications all over the country. Invariably the judgment rendered on its performance is the same—unqualifiedly and enthusiastically favorable.

The Novus Boiler is easy to tend; economical on fuel; staunch and dependable. Its pick-up is quick and effective—a valuable feature.

Properly located cleaning doors make it easy to remove any accumulation. Their presence makes it difficult to overlook this simple but extremely important task. Soot is a highly objectionable insulator, which may reduce efficiency as much as 25%.

A skimmer tapping is provided, which will effectively clear the boiler of oil, that deadly enemy of efficiency. Draining the boiler from the bottom will not do this. The oil clings to the sides of the sections, floating again when the boiler is refilled.

Standard equipment on the steam boilers includes an all-metal, all-inclosed sensitive damper regulator, that opens and closes the drafts to keep the pressure uniform; a retard steam gauge, with non-glare dial and water seal; an A. S. M. E. standard pop safety valve; a gauge glass, tri-cocks, and firing tools. No accessories other than firing tools are regularly furnished with Novus Water Boilers.

National No. 20-8-S Interior View

A DOUBLE set of three flue-ways are formed by numerous water tubes, around which the flames swirl in their long forward and back travel. This feature naturally produces high efficiency in coal burning, and also admirably fits the unit for economically burning oil.

Complete data and dimensions are given on pages 62 and 63.

The Crown . . .

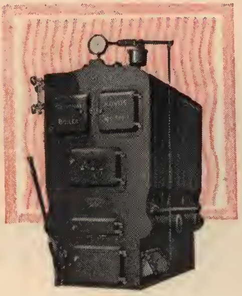
of Service and Superiority

IN the crown sheet of the Novus Boiler is found a feature that contributes largely to its superiority; it is the large area of overhanging direct fire surface.

In all cases this overhanging surface is arched across the boiler. In the 48 series, the overhang forms an integral part of the crown sheet. In the other series this overhang is in the form of an arched rib, joined to the crown sheet at its top, and to the water legs at its ends.

A large portion of the water in the boiler is thus brought into the area of greatest temperature, absorbing a large quantity of heat units before the hot gases enter the flues. After the gases have entered, they pass forward through flue-ways, entirely surrounded by water, and then back through another set of flues to the stack. All along their path their heat is being rapidly absorbed, so that stack temperatures and heat loss are reduced to a minimum.

Efficient combustion is promoted by the progressive increase in combustion area, permitting the gases to expand naturally. This feature, combined with the large amount of prime heating surface, and the long fire-travel, is responsible for the success of the Novus Boiler in oil and gas-burning operations as well as in the field of coal-burning.



Series No. 20—Sizes and Ratings

For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
20-5-S	900	480	3.12	2-3″	2-3″	8 x 12	35	28
20-6-S	1,100	600	3.91	2-3″	2-3″	8 x 12	35	32
20-7-S	1,300	720	4.70	3-3″	4-3″	8 x 12	35	36
20-8-S	1,500	840	5.49	3-3″	4-3″	8 x 12	40	40

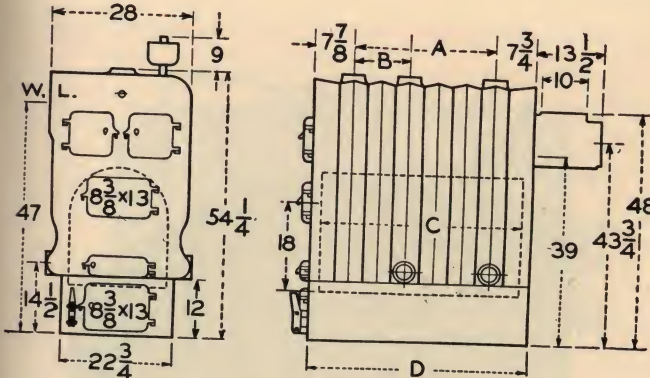
Water

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
5-20-W	1,500	790	3.12	2-3″	2-3″	8 x 12	35	28
6-20-W	1,850	990	3.91	2-3″	2-3″	8 x 12	35	32
7-20-W	2,200	1,190	4.70	3-3″	4-3″	8 x 12	35	36
8-20-W	2,550	1,390	5.49	3-3″	4-3″	8 x 12	40	40

†Square feet of exterior boiler surface.

Approximately 36 pounds of insulation per section required to provide boiler covering 1½ inches thick.

100 pounds of insulation will cover approximately 15 square feet of boiler surface to a thickness of 1½ inches.



Series No. 20—Steam and Water Dimensions

Boiler Numbers		A	B	C	D
20-5-S	5-20-W	11¾	....	23⅛	27¾
20-6-S	6-20-W	17⅝	....	29	33½
20-7-S	7-20-W	23½	11¾	34⅞	39¼
20-8-S	8-20-W	29⅜	17⅝	40¾	45

Measurements are subject to slight variations in assembly.
Ashpit and foundation measurements are shown on page 88.
Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections. Distance from center of one section to center of section next to it 5⅞ inches.
Return Inlet Tappings: One on each side of intermediate supply outlet Section "R".
Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

Standard Assembly of Boiler Sections

F—Front; I—Intermediate Plain; T°—Intermediate Supply Outlet, no Return Inlets; R°—Intermediate Supply Outlet, 2 Return Inlets; B—Back, no Return Inlets.

Boiler Numbers		Arrangement of Sections 1	2	3	4	5	6	7	8	Shaking Grates
20-5-S	20-W-5	F	T°	I	R°	B				4
20-6-S	20-W-6	F	T°	I	I	R°	B			5
20-7-S	20-W-7	F	T°	I	R°	I	R°	B		6
20-8-S	20-W-8	F	T°	I	I	R°	I	R°	B	7

National No. 25-8-S

IN thousands of installations throughout the country this boiler has demonstrated its dependability and efficiency. Due to the scientific proportioning of its combustion chamber, and the arrangement of the heating surface, this boiler will economically burn all types of fuel.

This boiler is made in five sizes, and is bonded to heat from 700 to 1400 feet of steam radiation, and 1150 to 2310 feet of water radiation.

National No. 25-8-S Interior View

A FIRE travel two and one half times the length of the boiler gives to this unit outstanding heating qualities and high efficiency. The flames pass through and over the arched crown sheet to the rear of the boiler, where they are drawn up into the two side flues, through which they pass to the front of the boiler. Here the two streams of burning gases unite, and progress to the rear of the boiler, and out, through the central flue.

Complete data and dimensions on pages 66 and 67.

Series No. 25
Sizes and Ratings
For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
25-5-S	1,475	700	4.78	2-4″	2-4″	12 x 12	30	39
25-6-S	1,800	875	5.95	2-4″	2-4″	12 x 12	35	45
25-7-S	2,125	1,050	7.12	3-4″	4-4″	12 x 12	35	51
25-8-S	2,450	1,225	8.29	3-4″	4-4″	12 x 12	40	57
25-9-S	2,775	1,400	9.46	3-4″	4-4″	12 x 16	45	63

Water

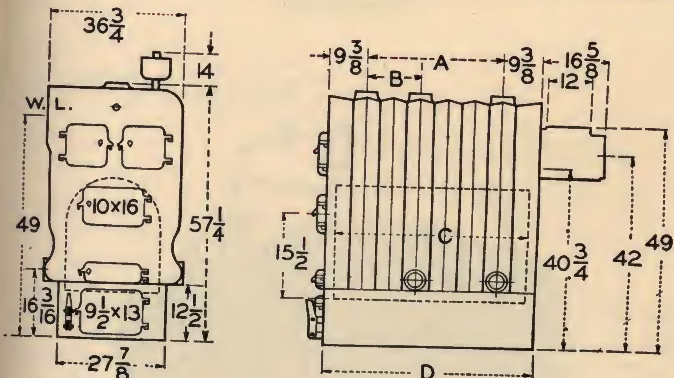
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
5-25-W	2,400	1,150	4.78	2-4″	2-4″	12 x 12	30	39
6-25-W	2,900	1,440	5.95	2-4″	2-4″	12 x 12	35	45
7-25-W	3,500	1,730	7.12	3-4″	4-4″	12 x 12	35	51
8-25-W	4,000	2,020	8.29	3-4″	4-4″	12 x 12	40	57
9-25-W	4,500	2,310	9.46	3-4″	4-4″	12 x 16	45	63

† Square feet of exterior boiler surface. Approximately 48 pounds of insulation per section required to provide boiler covering 1½ inches thick.

Return Inlet Tappings: One on each side of next-to-back section "RU". Additional inlets on each side of intermediate outlet section "R" in 7, 8, and 9 section boilers.

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

NATIONAL BONDED NOVUS SECTIONAL BOILERS



Series No. 25—Steam and Water Dimensions

Boiler Numbers		A	B	C	D
25-5-S	5-25-W	13¾″	.....	28⅛″	33¼″
25-6-S	6-25-W	20⅝″	.....	35 ″	40⅛″
25-7-S	7-25-W	27½″	13¾″	41⅞″	47 ″
25-8-S	8-25-W	34⅜″	13¾″	48¾″	53⅞″
25-9-S	9-25-W	41¼″	20⅝″	55⅝″	60¾″

Measurements are subject to slight variations in assembly.
Ashpit and foundation measurements are shown on page 88.

Standard Assembly of Boiler Sections

F—Front; I—Intermediate Plain; T°—Intermediate supply outlet, no return inlets; R°—Intermediate supply outlet, and 2 return inlets; RU°—Half uptake next to back, supply outlet and 2 return inlets; B—Back, no returns.

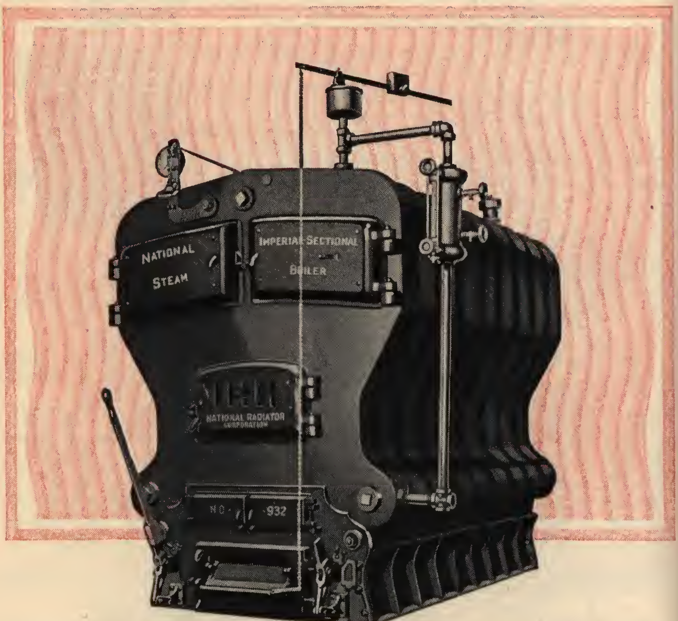
Arrangement of Sections

Boiler Numbers		1	2	3	4	5	6	7	8	9	Shaking Grates Front	Shaking Grates Back
25-5-S	5-25-W	F	T°	I	RU°	B					2	2
25-6-S	6-25-W	F	T°	I	I	RU°	B				3	2
25-7-S	7-25-W	F	T°	I	R°	I	RU°	B			3	3
25-8-S	8-25-W	F	T°	I	R°	I	I	RU°	B		4	3
25-9-S	9-25-W	F	T°	I	I	R°	I	I	RU°	B	4	4

Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections. Distance from center of one section to center of section next to it 6⅞ inches.
All grate bars are interchangeable

NATIONAL BONDED IMPERIAL SECTIONAL BOILERS

(Utica Design)



National No. S-932

AS the Utica Imperial Sectional Boiler, this unit built up an enviable reputation. Now, improved and refined, it is winning new laurels.

It is made in five sizes, and is bonded to heat from 1200 to 2400 square feet of steam radiation, and from 1980 to 3960 square feet of water radiation.

Companions . . .

In Achievement and Performance

THE 32 and 42 Series, National Imperial Sectional Boilers, were the hard coal companions of the renowned Utica Imperial Super-Smokeless Boiler. (Now the National Super-Smokeless Boiler).

By outstanding performance they demonstrated their dependability, proved their efficiency, and won the right to be included in the famous National Sectional Line of boilers.

These boilers were introduced more than 20 years ago. The first installations demonstrated the soundness of their design, and subsequent improvements have continuously kept them in an advanced position.

This position has been maintained by strict adherance to rigid manufacturing standards. Each batch of metal is subjected to careful analysis. All machining is done to small limits, under constant careful supervision. Sections are tested on special machines under hydrostatic pressures more than four times as great as the boilers will ordinarily be called upon to carry in actual service.

Design — manufacture — performance — these things unite to make National Imperial-Sectional Boilers companions in achievement.

NATIONAL BONDED IMPERIAL SECTIONAL BOILERS
(Utica Design)

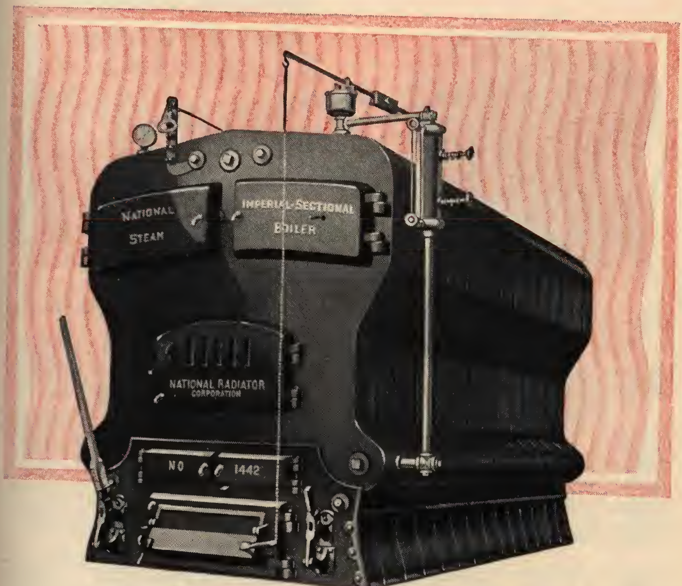
National No. S-1142 Interior View

THE burning gases travel twice the length of the boiler in a swirling, rotative manner, scouring the sides of the flue ways, and producing a high rate of heat transfer. The arched ribs, integral with the crown sheet, provide an abundance of prime heating surface.

The internal construction of the 32 series Imperial Sectional Boiler is practically identical with the 42 series illustrated above, the only difference being in the smaller grate widths.

Complete Data and Dimensions, 32 series, on pages 72-73 and 74-75; 42 series, pages 72-73 and 76-77.

NATIONAL BONDED IMPERIAL SECTIONAL BOILERS
(Utica Design)



National No. S-1442

IN schools, apartments, hospitals and similar applications, this boiler—under the name of the Utica Imperial Sectional Boiler—has won and retained an outstanding reputation. Because of the interior construction it is ideally adapted for oil burning.

It is made in eleven sizes, and is bonded to heat 2200 to 6700 square feet of steam radiation, and from 3625 to 11000 square feet of water radiation.

NATIONAL BONDED IMPERIAL SECTIONAL BOILERS
(Utica Design)

Series No. 32 and 42
Sizes and Ratings
For Steam and Vapor

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam Series No. 32

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		‡Covering Surface Sq. Ft.
						Area Inches	Height Feet	
S-532	2,900	1,200	7.32	2-5″	2-4″	14 x 14	40	42
S-632	3,600	1,500	9.10	2-5″	2-4″	15 x 15	40	51
S-732	4,300	1,800	10.87	2-5″	2-4″	16 x 16	40	60
S-832	5,000	2,100	12.65	2-5″	2-4″	16 x 16	50	69
S-932	5,700	2,400	14.42	3-5″	2-4″	18 x 18	50	78

Steam Series No. 42

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney Area Inches	Chimney Height Feet	‡Covering Surface Sq. Ft.
S-642	5,200	2,200	12.03	2-5″	2-4″	16 x 16	50	56
S-742	6,200	2,700	14.38	2-5″	2-4″	18 x 18	50	66
S-842	7,200	3,200	16.73	3-5″	2-4″	18 x 18	55	76
S-942	8,200	3,700	19.08	3-5″	2-4″	20 x 20	55	86
S-1042	9,200	4,200	21.43	3-5″	2-4″	20 x 20	60	96
S-1142	10,200	4,700	23.77	3-5″	2-4″	21 x 21	60	106
S-1242	11,200	5,100	26.12†	4-5″	2-4″	22 x 22	65	116
S-1342	12,200	5,500	28.47†	4-5″	2-4″	22 x 22	70	126
S-1442	13,000	5,900	30.82†	4-5″	2-4″	23 x 23	75	136
S-1542	13,800	6,300	33.17†	4-5″	2-4″	23 x 23	75	146
S-1642	14,600	6,700	35.52†	4-5″	2-4″	24 x 24	80	156

† Maximum grate area that can be furnished. Unless otherwise ordered the S-1242 is shipped with 9 grate bars having a grate area of 21.43 square feet, the S-1342, S-1442 and S-1542 with 10 grate bars having a grate area of 23.77 square feet, and the S-1642 with 11 grate bars having a grate area of 26.12 square feet.

‡Square feet of exterior boiler surface.

Series No. 32 requires approximately 60 pounds and Series No. 42 approximately 67 pounds of insulation per section to provide boiler covering 1½ inches thick.

NATIONAL BONDED IMPERIAL SECTIONAL BOILERS
(Utica Design)

Series No. 32 and 42
Sizes and Ratings
For Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Water Series No. 32

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		‡Covering Surface Sq. Ft.
						Area Inches	Height Feet	
W-532	4,650	1,980	7.32	2-5″	2-4″ 2-5″	14 x 14	40	42
W-632	5,800	2,475	9.10	2-5″	2-4″ 2-5″	15 x 15	40	51
W-732	6,950	2,970	10.87	2-5″	2-4″ 2-5″	16 x 16	40	60
W-832	8,100	3,465	12.65	2-5″	2-4″ 2-5″	16 x 16	50	69
W-932	9,250	3,960	14.42	3-5″	2-4″ 2-5″	18 x 18	50	78

Water Series No. 42

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney Area Inches	Chimney Height Feet	‡Covering Surface Sq. Ft.
W-642	8,300	3,625	12.03	2-5″	2-4″ 2-5″	16 x 16	50	56
W-742	9,900	4,450	14.38	2-5″	2-4″ 2-5″	18 x 18	50	66
W-842	11,500	5,275	16.73	3-5″	2-4″ 2-5″	18 x 18	55	76
W-942	13,100	6,100	19.08	3-5″	2-4″ 2-5″	20 x 20	55	86
W-1042	14,700	6,925	21.43	3-5″	2-4″ 2-5″	20 x 20	60	96
W-1142	16,300	7,750	23.77	3-5″	2-4″ 2-5″	21 x 21	60	106
W-1242	17,900	8,400	26.12†	4-5″	2-4″ 4-5″	22 x 22	65	116
W-1342	19,500	9,050	28.47†	4-5″	2-4″ 4-5″	22 x 22	70	126
W-1442	20,800	9,700	30.82†	4-5″	2-4″ 4-5″	23 x 23	75	136
W-1542	22,100	10,350	33.17†	4-5″	2-4″ 4-5″	23 x 23	75	146
W-1642	23,400	11,000	35.52†	4-5″	2-4″ 4-5″	24 x 24	80	156

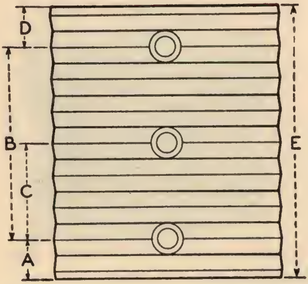
† Maximum grate area that can be furnished. Unless otherwise ordered the W-1242 is shipped with 9 grate bars having a grate area of 21.43 sq. ft., the W-1342, W-1442 and W-1542 with 10 grate bars having a grate area of 23.77 sq. ft. and the W-1642 with 11 grate bars having a grate area of 26.12 sq. ft.

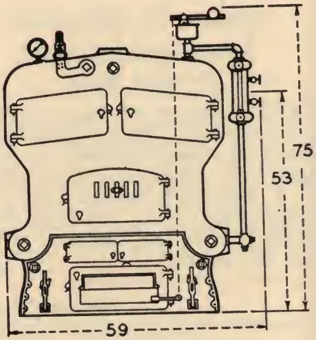
‡ Square feet of exterior boiler surface.

Series No. 32 requires approximately 60 pounds and Series No. 42 approximately 67 pounds of insulation per section to provide boiler covering 1½ inches thick.

NATIONAL BONDED IMPERIAL SECTIONAL BOILERS

(Utica Design)





Series No. 32 Dimensions

Steam and Water

Boiler Number	A	B	C	D	E	F	G	H
532	10⅜″	16½″	..	10⅜″	37¼″	32½″	38¼″	10½″
632	10⅜″	24¾″	..	10⅜″	45½″	40¾″	46½″	10½″
732	10⅜″	33 ″	..	10⅜″	53¾″	49 ″	54¾″	10½″
832	10⅜″	41¼″	..	10⅜″	62 ″	57¼″	63 ″	10½″
932	10⅜″	49½″	24¾″	10⅜″	70¼″	65½″	71¼″	10½″

Measurements subject to slight variations in assembly.

Ashpit and foundation measurements are shown on page 89.

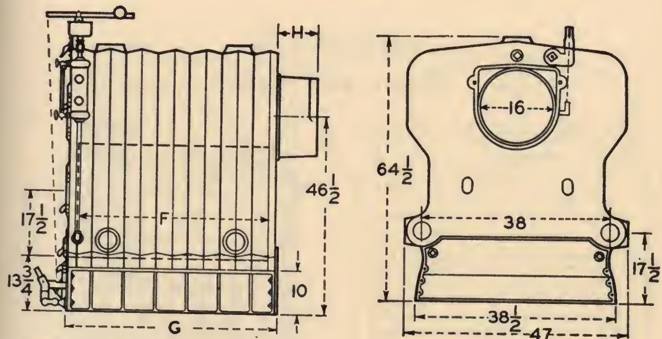
Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections page 75. Distance from center of one section to center of section next to it 8¼ inches.

Steam Return Inlet Tappings: Two 4″ in rear of back section "B". Side return inlets on steam boilers are only furnished on special order.

Water Return Inlet Tappings: Two 4″ in rear of back section "B". Additional 5″ return inlets on each side of intermediate supply outlet section "LR".

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping. See current trade price sheet for charge for additional tappings.

(Utica Design)



Series No. 32 Steam and Water
Standard Assembly of Boiler Sections

F—Front; L—Low Crown Intermediate, Plain; LT° —Low Crown Intermediate, supply outlet, no return inlet; LR°—Low Crown Intermediate, supply outlet, 2 return inlets (1 on each side); UT°—Low Crown Intermediate, Half Uptake, supply outlet, no return inlet; B—Back, 2 return inlets on rear.

Arrangements of Sections

Steam

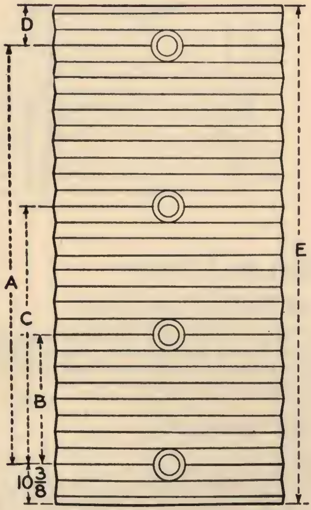
Boiler Number	1	2	3	4	5	6	7	8	9	Shaking Grates Left	Shaking Grates Right
S-532	F	LT°	L	UT°	B					2	2
S-632	F	LT°	L	L	UT°	B				3	2
S-732	F	LT°	L	L	L	UT°	B			3	3
S-832	F	LT°	L	L	L	L	UT°	B		4	3
S-932	F	LT°	L	L	LT°	L	L	UT°	B	4	4

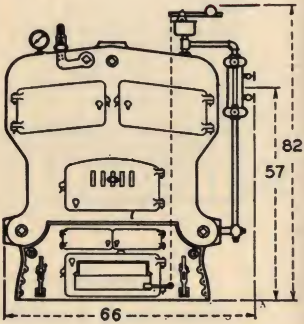
Water

Boiler Number	1	2	3	4	5	6	7	8	9	Shaking Grates Left	Shaking Grates Right
W-532	F	LR°	L	UT°	B					2	2
W-632	F	LR°	L	L	UT°	B				3	2
W-732	F	LR°	L	L	L	UT°	B			3	3
W-832	F	LR°	L	L	L	L	UT°	B		4	3
W-932	F	LR°	L	L	LT°	L	L	UT°	B	4	4

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 8¼″.

Series No. 42
Steam and Water



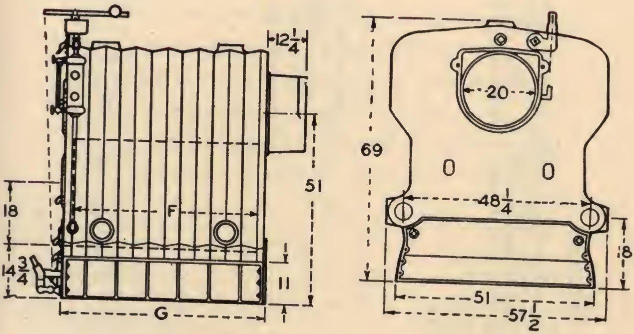


SUPPLY Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after the Key letter in Standard Assembly of Boiler Sections on pages 78-79. Distance from center of one section to center of section next to it is $8\frac{1}{4}$ inches.

Steam Inlet Tappings: Two 4″ in rear of back section "B". Side return inlets on steam boilers are only furnished on special order.

Water Return Inlet Tappings: Two 4″ in rear of back section "B". Additional 5″ return tappings on both sides of each intermediate supply outlet section "LR".

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional $1\frac{1}{2}$ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.



Series No. 42
Steam and Water Dimensions

Boiler Number	A	B	C	D	E	F	G
642	24¾″	.....	.....	10⅜″	45½″	40¾″	47 ″
742	33 ″	.....	.....	10⅜″	53¾″	49 ″	55¼″
842	41¼″	16½″	.....	10⅜″	62 ″	57¼″	63½″
942	49½″	24¾″	.....	10⅜″	70¼″	65½″	71¾″
1042	57¾″	33 ″	.....	10⅜″	78½″	73¾″	80 ″
1142	66 ″	41¼″	.....	10⅜″	86¾″	82 ″	88¼″
1242	74¼″	24¾″	49½″	10⅜″	95 ″	73¾″	96½″
1342	82½″	24¾″	49½″	10⅜″	103¼″	82 ″	104¾″
1442	82½″	24¾″	49½″	18⅝″	111½″	82 ″	113 ″
1542	90¾″	24¾″	49½″	18⅝″	119¾″	82 ″	121¼″
1642	99 ″	33 ″	57¾″	18⅝″	128 ″	90¼″	129½″

Measurements subject to slight variations in assembly.
Ashpit and foundation measurements are given on page 89.

Series No. 42

Standard Assembly of Boiler Sections

F—Front; **XT°**—Low crown intermediate, crossover flue next to front, supply outlet, no return inlet; **L**—Low crown intermediate, plain; **LT°**—Low crown intermediate, supply outlet, no return inlet; **H**—High crown intermediate, plain; **K**—Bridgewall; **UT°**—Low crown intermediate, half uptake, supply outlet, no return inlet; **W**—Low crown intermediate, full uptake, plain; **WT°**—Low crown intermediate, full uptake, supply outlet, no return inlet; **B**—Back, 2 return inlets on rear.

Arrangement of Sections

Steam Boilers

Boiler Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Shaking Grates	
																	Left	Right
S-642	F	LT°	L	L	UT°	B											3	2
S-742	F	LT°	L	L	L	UT°	B										3	3
S-842	F	XT°	L	LT°	L	L	UT°	B									4	3
S-942	F	XT°	L	L	LT°	L	L	WT°	B								4	4
S-1042	F	XT°	L	L	L	LT°	L	L	WT°	B							5	4
S-1142	F	XT°	L	L	L	L	LT°	L	L	WT°	B						6	4
S-1242	F	XT°	L	L	LT°	L	L	LT°	H	K	WT°	B					5	4
S-1342	F	XT°	L	L	LT°	L	L	LT°	L	H	K	WT°	B				6	4
S-1442	F	XT°	L	L	LT°	L	L	LT°	L	H	K	UT°	W	B			6	4
S-1542	F	XT°	L	L	LT°	L	L	LT°	L	H	K	H	WT°	W	B		6	4
S-1642	F	XT°	L	L	L	LT°	L	L	LT°	L	H	K	H	WT°	W	B	6	5

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 8¼ inches.

Series No. 42
Standard Assembly of Boiler Sections

F—Front: XT°—Low crown intermediate, crossover flue next to front, supply outlet, no return inlet; L—Low crown intermediate, plain; LR°—Low crown intermediate, supply outlet, 2 return inlets, (1 on each side); H—High crown intermediate, plain; K—Bridgewall; UT°—Low crown intermediate, half uptake, supply outlet, no return inlet; W—Low crown intermediate, full uptake, plain; WT°—Low crown intermediate, full uptake, supply outlet, no return inlet; B—Back, 2 return inlets on rear.

Arrangement of Sections
Water Boilers

Boiler Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	Shaking Grates	
																	Left	Right
W-642	F	LR°	L	L	UT°	B											3	2
W-742	F	LR°	L	L	L	UT°	B										3	3
W-842	F	XT°	L	LR°	L	L	UT°	B									3	3
W-942	F	XT°	L	L	LR°	L	L	WT°	B								4	3
W-1042	F	XT°	L	L	L	LR°	L	L	WT°	B							4	4
W-1142	F	XT°	L	L	L	L	LR°	L	L	WT°	B						5	4
W-1242	F	XT°	L	L	LR°	L	L	LR°	H	K	WT°	B					6	4
W-1342	F	XT°	L	L	LR°	L	L	LR°	L	H	K	WT°	B				5	4
W-1442	F	XT°	L	L	LR°	L	L	LR°	L	H	K	UT°	W	B			6	4
W-1542	F	XT°	L	L	LR°	L	L	LR°	L	H	K	H	WT°	W	B		6	4
W-1642	F	XT°	L	L	L	LR°	L	L	LR°	L	H	K	H	WT°	W	B	6	5

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 8¼ inches.

National—No. 48-10-S

THIS substantially constructed heating unit was particularly designed for heavy duty service. It has long been a favorite for schools, hospitals, large apartments and similar structures, where a boiler must have reserve capacity to meet quickly and efficiently sudden demands for heat.

This boiler is made in 6 sizes, and is bonded to heat 3500 to 7000 square feet of steam radiation, and 5750 to 11,500 square feet of hot water radiation.

United . . .

for service divided for portability

National Series
No. 48 partially assembled

THE Series 48 National Novus Boiler is made in twin sections, to facilitate handling and assembly. The half sections can be easily carried through the ordinary basement door. Due to this feature, this boiler is widely used to replace broken or worn-out single unit boilers, installed before the building was constructed.

The half sections, because of their relatively low weight, simplify the erection of the boiler. The illustration at the right shows the recommended method of yoking together the two halves of the boiler, to connect with the return main.

National No. 48-8-S Interior View

A SERIES of ports in the overhanging arch increase the prime heating surface and provide a pathway for the hot gases as they are drawn to the rear of the boiler. From there they are drawn up into the two outer flue-ways, swirl and eddy to the front of the boiler, and then travel back through two central flue-ways. All these flue-ways are easily accessible through large doors, which facilitate cleaning, and permit the boiler to be run at high efficiency at all times.

Complete data and dimensions on pages 84 and 85.

Many Sizes . . .

But One Rigid Manufacturing Standard

FROM the smallest 20-series, to the largest 48, each Novus boiler is made in strict conformity to a high and unchanging manufacturing standard. This care makes Novus Boilers easy to assemble on the job into steam-and-water heating units, permanently tight, and that will be dependable and effective.

All metal used in these boilers is carefully tested in metallurgical laboratories to insure uniformity. The Seacoal finish, used on all castings, gives a uniform, smooth surface, free from flaws and defacements. Finishing and machining is done to narrow limits, and unbelievably small tolerances are permitted. Doors are ground to a fit on their frames, to prevent infiltration of air that might cool the fire, or short-circuit the draft.

Sections are tested on special machines, under hydrostatic pressures more than four times as great as the boilers will ordinarily be called upon to carry in actual service.

These things explain the long-continued popularity of Novus Boilers—their outstanding successes in all sorts of applications—their sterling and dependable performance under the most difficult conditions. The very name of Novus is a guarantee of happy satisfaction.

Series No. 48—
Sizes and Ratings
For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers, "Available Output" ratings are also shown.

Steam

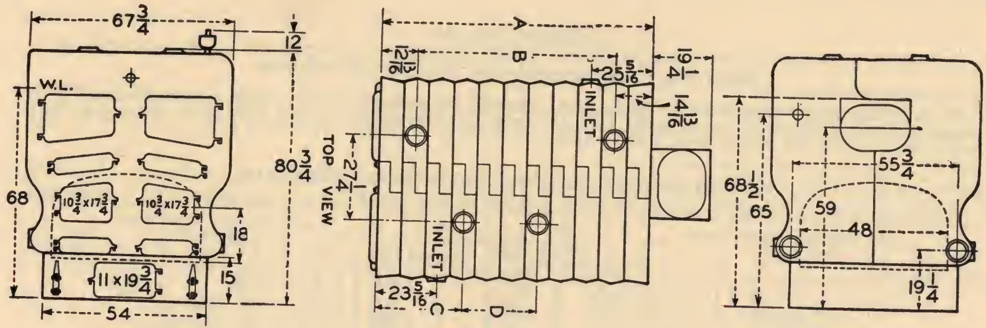
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
48-6-S	7,500	3,500	17.13	2-6″	2-4″	20 x 20	60	110
48-7-S	9,000	4,200	20.68	2-6″	2-4″	20 x 24	65	125
48-8-S	10,500	4,900	24.23	3-6″	2-4″	24 x 24	70	139
48-9-S	12,000	5,600	27.78	3-6″	2-4″	24 x 28	75	153
48-10-S	13,500	6,300	31.33	3-6″	2-4″	24 x 28	75	167
48-11-S	15,000	7,000	34.88	4-6″	2-4″	28 x 28	80	182

Water

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	* Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
6-48-W	12,100	5,750	17.13	2-6″	2-6″	20 x 20	60	110
7-48-W	14,500	6,900	20.68	2-6″	2-6″	20 x 24	65	125
8-48-W	17,000	8,050	24.23	3-6″	2-6″	24 x 24	70	139
9-48-W	19,300	9,200	27.78	3-6″	2-6″	24 x 28	75	153
10-48-W	21,700	10,350	31.33	3-6″	2-6″	24 x 28	75	167
11-48-W	24,100	11,500	34.88	4-6″	2-6″	28 x 28	80	182

† Square feet of exterior boiler surface. Approximately 114 pounds of insulation per section required to provide boiler covering 1½ inches thick.

*In addition to the inlets listed above there are two 4″ on the back section which must be yoked together.



Series No. 48—Steam and Water Dimensions

Boiler Numbers		A	B	C	D	Fire Box Length
48-6-S	6-48-W	59⅛"	31½"	.....	.....	50¾"
48-7-S	7-48-W	69⅝"	42 "	.....	.....	61¼"
48-8-S	8-48-W	80⅛"	52½"	33¾"	.....	71¾"
48-9-S	9-48-W	90⅝"	63 "	33¾"	.....	82¼"
48-10-S	10-48-W	101⅛"	73½"	44¼"	.....	92¾"
48-11-S	11-48-W	111⅝"	84 "	33¾"	31½"	103¼"

Measurements subject to slight variations in assembly. Clear width of fire box 48 inches; maximum width 49¼ inches.
Side tappings on center diagram are return inlet tappings in section "R" of water boilers only.
Oval smoke collar is equivalent to 20 inch round, top or rear outlet.
Ashpit and foundation measurements are shown on page 88.

Series No. 48

Standard Assembly of Boiler Sections

LF—Left front; **RF**—Right front; **I**—Intermediate plain; **T°**—Intermediate supply outlet, no return inlets; **TU°**—Left next to back half uptake, supply outlet, no return inlets; **IU**—Right next to back half uptake, plain; **LB**—Left back, 1 return inlet; **RB**—Right back, 1 return inlet.

Arrangement of Sections-Steam Boilers

Arrangement of Sections Left Half											No. Back Grates	Boiler No.	No. Front Grates	Arrangement of Sections Right Half										
11	10	9	8	7	6	5	4	3	2	1				1	2	3	4	5	6	7	8	9	10	11
					LB	TU°	I	I	T°	LF	2	48–6	3	RF	I	I	I	IU	RB					
				LB	TU°	I	I	I	T°	LF	3	48–7	3	RF	I	I	I	I	IU	RB				
			LB	TU°	I	I	I	I	T°	LF	3	48–8	4	RF	I	I	T°	I	I	IU	RB			
		LB	TU°	I	I	I	I	I	T°	LF	4	48–9	4	RF	I	I	T°	I	I	I	IU	RB		
	LB	TU°	I	I	I	I	I	I	T°	LF	4	48–10	5	RF	I	I	I	T°	I	I	I	IU	RB	
LB	TU°	I	I	I	I	I	I	I	T°	LF	5	48–11	5	RF	I	I	T°	I	I	T°	I	I	IU	RB

Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections. Distance from center of one section to center of section next to it is 10½ inches.

Return Inlet Tappings: One 4″ in rear of right back section "RB" and one 4″ in rear of left back section "LB" which must be yoked together.

Complete dimensions and center to center distance between tappings are shown on page 85.

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on outside of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

Series No. 48

Standard Assembly of Boiler Sections

LF—Left front; **RF**—Right front; **I**—Intermediate plain; **T°**—Intermediate supply outlet, no return inlets; **R**—Intermediate, no supply outlet, 1 return inlet on right or left side (section Reversible); **TU°**—Left next to back half uptake, supply outlet, no return inlet; **IU**—Right next to back half uptake, plain; **LB**—Left back, 1 return inlet; **RB**—Right back, 1 return inlet.

Arrangement of Sections-Water Boilers

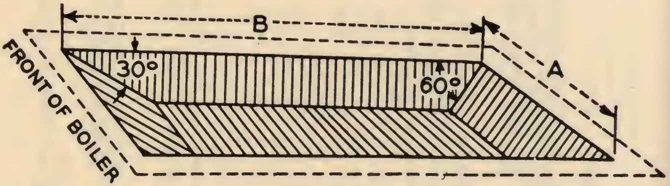
Arrangement of Sections Left Half											No. Back Grates	Boiler No.	No. Front Grates	Arrangement of Sections Right Half										
11	10	9	8	7	6	5	4	3	2	1				1	2	3	4	5	6	7	8	9	10	11
					LB	TU°	R	I	T°	LF	2	48–6	3	RF	I	R	I	IU	RB					
				LB	TU°	R	I	I	T°	LF	3	48–7	3	RF	I	R	I	I	IU	RB				
			LB	TU°	R	I	I	I	T°	LF	3	48–8	4	RF	I	R	T°	I	I	IU	RB			
		LB	TU°	R	I	I	I	I	T°	LF	4	48–9	4	RF	I	R	T°	I	I	I	IU	RB		
	LB	TU°	R	I	I	I	I	I	T°	LF	4	48–10	5	RF	I	R	I	T°	I	I	I	IU	RB	
LB	TU°	R	I	I	I	I	I	I	T°	LF	5	48–11	5	RF	I	R	T°	I	I	T°	I	I	IU	RB

Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections. Distance from center of one section to center of section next to it is 10½ inches.

Return Inlet Tappings: One 4″ in rear of right back section "RB" and one 4″ in rear of left back section "LB" which must be yoked together. One additional return tapping on side of intermediate section "R."

Complete dimensions and center to center distance between tappings are shown on page 85.

Series No. 20, 25 and 48
Foundation and Pitting Dimensions



WARPED and burned grate bars are in practically all cases due to the accumulation of ashes under grates. As a safety factor it is recommended that an ash pit similar to the above sketch be constructed. When basement floor is not yet laid, surround pit with foundation 10 to 12 inches wide. Complete dimensions are given below. A—width of ashpit. B—length of ashpit.

Series No. 20 Novus Sectional Boilers

Boiler Numbers		A	B	Depth of Pit
20-5-S	5-20-W	17″	25 ″	10″
20-6-S	6-20-W	17″	30¾″	10″
20-7-S	7-20-W	17″	36½″	10″
20-8-S	8-20-W	17″	42¼″	10″

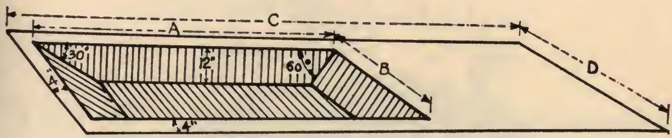
Series No. 25 Novus Sectional Boilers

25-5-S	5-25-W	22½″	30 ″	10″
25-6-S	6-25-W	22½″	36¾″	10″
25-7-S	7-25-W	22½″	43¾″	10″
25-8-S	8-25-W	22½″	50½″	10″
25-9-S	9-25-W	22½″	57½″	10″

Series No. 48 Novus Sectional Boilers

48-6-S	6-48-W	45″	52½″	12″
48-7-S	7-48-W	45″	63″	12″
48-8-S	8-48-W	45″	73½″	12″
48-9-S	9-48-W	45″	84 ″	12″
48-10-S	10-48-W	45″	94½″	12″
48-11-S	11-48-W	45″	105 ″	12″

Series No. 32 and 42
Foundation and Pitting Dimensions



Boiler Number	Measurements of Pit Under Ash Pit (In Inches)		Dimensions of Foundation (In Inches)	
	A	B	C	D
Series No. 32 National Imperial Sectional Boiler				
532	34	33½	43	41½
632	42¼	33½	51¼	41½
732	50½	33½	59½	41½
832	58¾	33½	67¾	41½
932	67	33½	76	41½
Series No. 42 National Imperial Sectional Boiler				
642	42¼	46	51¼	54
742	50½	46	59½	54
842	58¾	46	67¾	54
942	67	46	76	54
1042	75¼	46	84¼	54
1142	83½	46	92½	54
1242	75¼	46	100¾	54
1342	83½	46	109	54
1442	83½	46	117¼	54
1542	83½	46	125½	54
1642	91¾	46	133¾	54

When basement floor is not yet laid, surround pit with foundation 10 to 12 inches wide.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)

National No. S-248

THE sterling worth and outstanding performance of the large National Super-Smokeless Boilers are matters of common knowledge. Many, however, do not know that this boiler is also made in a small grate width, thus bringing to large residences, small apartments, and similar applications the array of advantages that have made the Super-Smokeless renowned.

The Series No. 24 is made in five sizes, and is bonded to heat from 750 to 1750 square feet of steam radiation and from 1250 to 2850 square feet of water radiation.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)

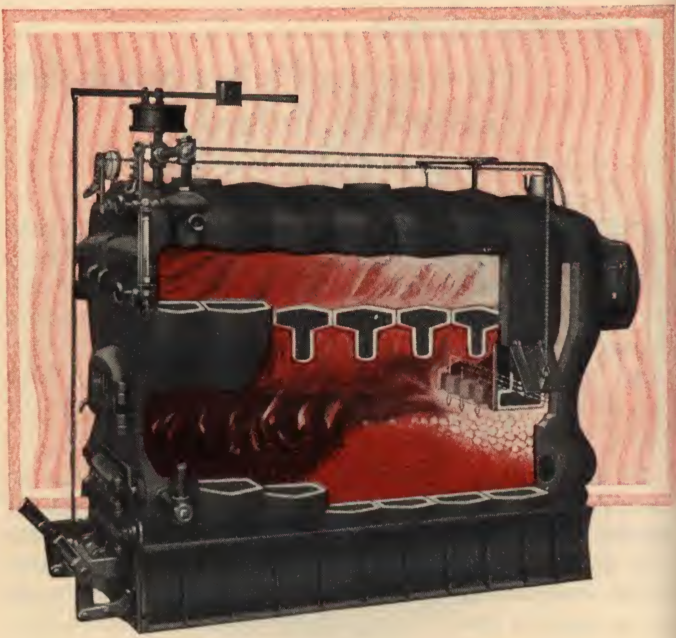
The Standard . . .

By which all other Smokeless Boilers are Judged

THE National Super-Smokeless Boiler was designed to meet the need for a boiler which would efficiently burn low grades of fuel and that could be easily fired. It was introduced in 1916 as the *Utica Imperial Super-Smokeless Boiler*. It quickly won the endorsement of architects, engineers, trade, and users. With the improvements made by National, it is today the leader in the smokeless boiler field.

So simple and fool-proof is the boiler that even an inexperienced fireman can handle it with excellent results. The coal is fed on the front of the grate, which acts as a gas producer and retort. The volatile matter (often containing as high as 32% of the total heat units in the coal) is then drawn toward the rear of the boiler, to be combined with the secondary air, and completely consumed.

The large amount of prime heating surface, the progressive increase in volume of the combustion area, and the long, rotative swirling travel of the incandescent gases, all contribute to the boiler's outstanding efficiency in burning low grades of fuel—and are of equal value when oil is used as fuel. Ratings and data on the National Super-Smokeless for this type of service are given in detail on pages 165 and 166.



National No. S-248 Interior View

THIS view graphically shows the long, swirling, rotative gas travel that cleans the flues, speeds heat transfer, and boosts efficiency. Note the PATENTED baffle section, where the pre-heated secondary air is introduced that causes complete combustion of all the gases.

Complete data and dimensions on pages 96 and 98.

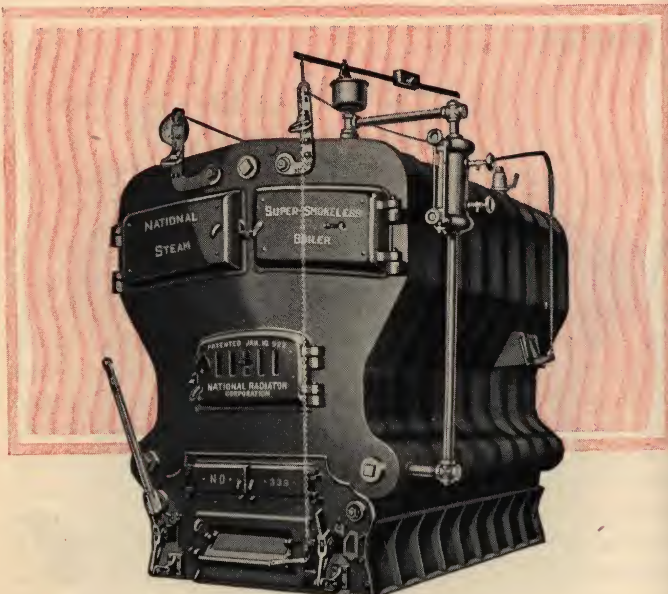
Saves . . .

its cost—
bans a nuisance

WHEN the National Super-Smokeless Boiler is used, all objectionable smoke is burned, and so a nuisance is abated. But in addition there is an outstanding saving in fuel cost. In the ordinary boiler, which operates at an efficiency of less than 60%, the smoke carries with it up the stack a large number of unconsumed heat units. The National Super-Smokeless Boiler utilizes a large proportion of these units which the ordinary boiler wastes, resulting in a startling increase in efficiency. An increase of only 10% in the efficiency, at this range, saves about 15 tons out of every one hundred fired. For if a boiler is called on to deliver all the heat contained in 60 tons of coal, at an efficiency of 60%, 100 tons must be burned to provide it. At 70% efficiency only 6/7 as much coal—or about 85 tons—need be used. This makes the saving 15 tons.

Accessories furnished with the National Super-Smokeless Boiler are of proved dependability. For the steam boiler there is furnished an all-metal, all-inclosed damper regulator, sensitive and husky; a Bourdon tube-type retard gauge, with water seal and non-glare dial; a gauge glass; tri-cocks; an A. S. M. E. pop safety valve; and firing tools. The water boiler is not furnished with accessories, except fire tools.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)



National No. S-339

THE superior design of the Utica Imperial Super-Smokeless Boiler was quickly recognized when the boiler was first introduced more than fourteen years ago, and the Super-Smokeless soon became the standard of all smokeless boilers. It has maintained this leadership because of fuel economy, ease of firing, and dependability.

The Series 33 is made in six sizes, and is bonded to heat from 1300 to 3050 square feet of steam radiation, and from 2150 to 5025 square feet of water radiation.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)

Distinguished . . .

for, and by, its swirling scarlet flame

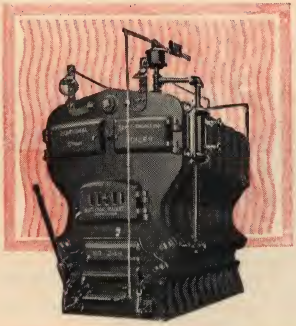
BECAUSE of the exclusive design of the National Super-Smokeless Boiler, the gases are induced to travel in a rapid, swirling rotative manner. The nominal travel is twice the length of the boiler, but because of the rotative travel, the fire travel is actually much longer. The hot gases in their course constantly rub against the walls of the flue ways, resulting in a high rate of heat absorption. This constant rubbing has another effect, also; the swirling gases "scour" the walls of the flues, keeping them clean.

This last feature is highly important, as soot is a highly objectionable insulator. Neglect in cleaning it out of ordinary boilers frequently decreases efficiency as much as 25%. In the Super-Smokeless Boiler, the dependence on the human element is minimized, as the boiler practically cleans itself.

The swirling scarlet flame that spins through the flues of the National Super-Smokeless is a sight that impresses everyone who sees it. It implies a promise of efficiency that the boiler in practice, abundantly fulfills. For it, and by it, the National Super-Smokeless Boiler is distinguished.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)



Series No. 24
Sizes and Ratings
For
Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Steam

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
S-245	1,600	750	5.00	1-4″	2-3″	12 x 12	40	34
S-246	2,000	1,000	6.25	2-4″	2-3″	13 x 13	40	42
S-247	2,400	1,250	7.50	2-4″	2-3″	13 x 13	45	50
S-248	2,800	1,500	8.75	2-4″	2-3″	14 x 14	50	58
S-249	3,200	1,750	10.00	3-4″	2-3″	14 x 14	55	64

Water

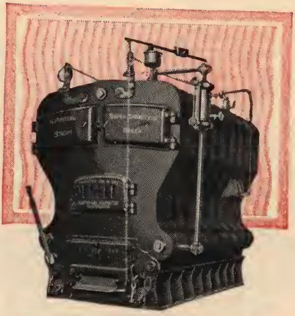
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets No. and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
W-245	2,600	1,250	5.00	1-4″	2-3″ 2-4″	12 x 12	40	34
W-246	3,250	1,650	6.25	2-4″	2-3″ 2-4″	13 x 13	40	42
W-247	3,900	2,050	7.50	2-4″	2-3″ 2-4″	13 x 13	45	50
W-248	4,550	2,450	8.75	2-4″	2-3″ 2-4″	14 x 14	50	58
W-249	5,200	2,850	10.00	3-4″	2-3″ 2-4″	14 x 14	55	64

† Square feet of exterior boiler surface. Approximately 50 pounds of insulation per section required to provide boiler covering 1½ inches thick. 100 pounds of insulation will cover approximately 15 square feet of boiler surface to a thickness of 1½ inches.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)

Series No. 33
Sizes and Ratings
For
Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.



Steam

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
S-335	2,900	1,300	7.32	1-5″	2-4″	14 x 14	40	42
S-336	3,600	1,650	9.10	2-5″	2-4″	15 x 15	40	51
S-337	4,300	2,000	10.87	2-5″	2-4″	16 x 16	40	60
S-338	5,000	2,350	12.65	2-5″	2-4″	16 x 16	50	69
S-339	5,700	2,700	14.42	3-5″	2-4″	18 x 18	50	78
S-3310	6,400	3,050	16.20	3-5″	2-4″	18 x 18	55	87

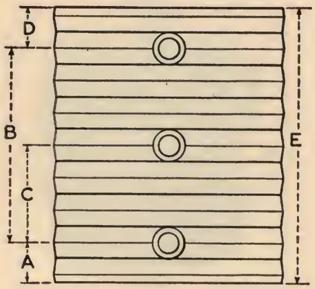
Water

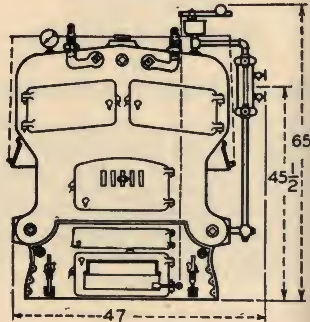
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets No. and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
W-335	4,650	2,150	7.32	1-5″	2-4″ 2-5″	14 x 14	40	42
W-336	5,800	2,725	9.10	2-5″	2-4″ 2-5″	15 x 15	40	51
W-337	6,950	3,300	10.87	2-5″	2-4″ 2-5″	16 x 16	40	60
W-338	8,100	3,875	12.65	2-5″	2-4″ 2-5″	16 x 16	50	69
W-339	9,250	4,450	14.42	3-5″	2-4″ 2-5″	18 x 18	50	78
W-3310	10,400	5,025	16.20	3-5″	2-4″ 2-5″	18 x 18	55	87

† Square feet of exterior boiler surface. Approximately 60 pounds of insulation per section required to provide boiler covering 1½ inches thick. 100 pounds of insulation will cover approximately 15 square feet of boiler surface to a thickness of 1½ inches.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)





Series No. 24
Steam and Water Dimensions

Boiler Number	A	B	C	D	E	F	G	H
245	18⅝″	.....	.....	18⅝″	37¼″	32½″	38¼″	9½″
246	10⅜″	16½″	.....	18⅝″	45½″	40¾″	46½″	9½″
247	10⅜″	24¾″	.....	18⅝″	53¾″	49 ″	54¾″	9½″
248	10⅜″	33 ″	.....	18⅝″	62 ″	57¼″	63 ″	9½″
249	10⅜″	41¼″	24¾″	18⅝″	70¼″	65½″	71¼″	9½″

Measurements are subject to slight variations in assembly.

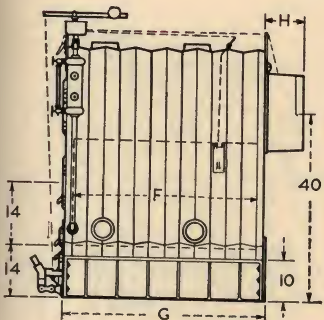
Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter in Standard Assembly of Boiler Sections on page 99. Distance from center of one section to center of section next to it is 8¼ inches.

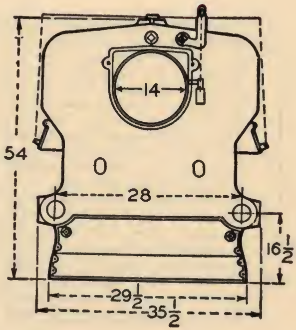
Steam Return Inlet Tappings: Two 3″ in rear of back section "B". Side return inlets on steam boilers are only furnished on special order.

Water Return Inlet Tappings: Two 3″ in rear of back section "B". Additional 4″ return tappings on each side of intermediate section "LR".

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)





Series No. 24
Standard Assembly of Boiler Sections

F—Front; **L**—Low crown intermediate, plain; **LT°**—Low crown intermediate, supply outlet, no return inlet; **LR°**—Low crown intermediate, supply outlet, 2 return inlets (1 on each side); **AU**—Baffle, air gates, half-uptake, plain; **B**—Back, 2 return inlets on rear.

Arrangement of Sections
Steam Boilers

Boiler Number	1	2	3	4	5	6	7	8	9	Shaking Grates	
										Left	Right
S-245	F	L	LT°	AU	B					2	2
S-246	F	LT°	L	LT°	AU	B				3	2
S-247	F	LT°	L	L	LT°	AU	B			3	3
S-248	F	LT°	L	L	L	LT°	AU	B		4	3
S-249	F	LT°	L	L	LT°	L	LT°	AU	B	4	4

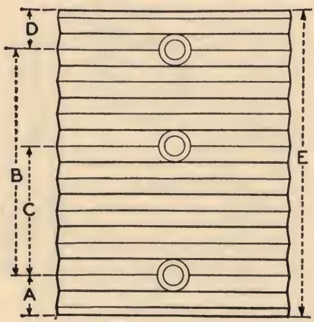
Water Boilers

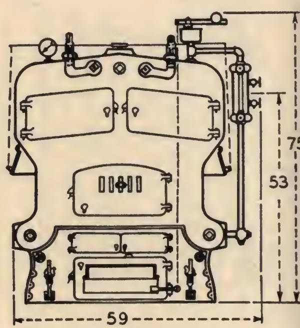
W-245	F	L	LR°	AU	B					2	2
W-246	F	LT°	L	LR°	AU	B				3	2
W-247	F	LT°	L	L	LR°	AU	B			3	3
W-248	F	LT°	L	L	L	LR°	AU	B		4	3
W-249	F	LT°	L	L	LT°	L	LR°	AU	B	4	4

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 8¼ inches.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)





Series No. 33

Steam and Water Dimensions

Boiler Number	A	B	C	D	E	F	G	H
335	18⅝"	.....	.....	18⅝"	37¼"	32½"	38¼"	10½"
336	10⅜"	16½"	.....	18⅝"	45½"	40¾"	46½"	10½"
337	10⅜"	24¾"	.....	18⅝"	53¾"	49 "	54¾"	10½"
338	10⅜"	24¾"	.....	26⅞"	62 "	57¼"	63 "	10½"
339	10⅜"	49½"	24¾"	10⅜"	70¼"	65½"	71¼"	10½"
3310	10⅜"	57¾"	24¾"	10⅜"	78½"	73¾"	79½"	10½"

Measurements subject to slight variations in assembly.

Ashpit and foundation measurements are shown on page 122.

Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letters, in Standard Assembly of Boiler Sections on page 101. Distance from center of one section to center of section next to it is 8¼ inches.

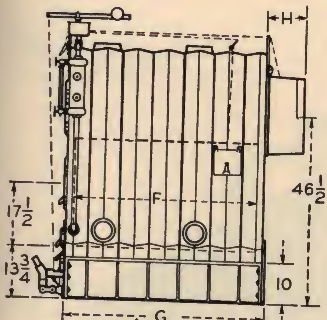
Steam Return Inlet Tappings: Two 4" in rear of back section "B". Side return inlets on steam boilers are only furnished on special order.

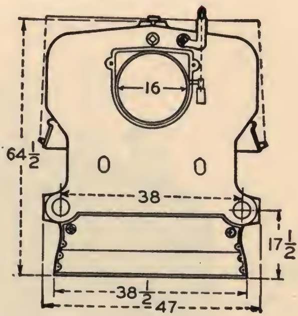
Water Return Inlet Tappings: Two 4" in rear of back section "B". Additional 5" return inlets on each side of intermediate supply outlet section "HR".

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)





Series No. 33

Standard Assembly of Boiler Sections

F—Front; **L**—Low Crown intermediate, plain; **LT°**—Low Crown intermediate, supply outlet, no return inlet; **H**—High crown intermediate, plain; **HT°**—High crown intermediate, supply outlet, no return inlet; **HR°**—High crown intermediate, supply outlet, 2 return inlets (1 on each side); **A**—Baffle, air gates, plain; **AU**—Baffle, air gates, half uptake, plain; **WT°**—Low crown intermediate, full uptake, supply outlet, no return inlet; **B**—Back, 2 return inlets on rear.

Arrangement of Sections

Steam Boilers

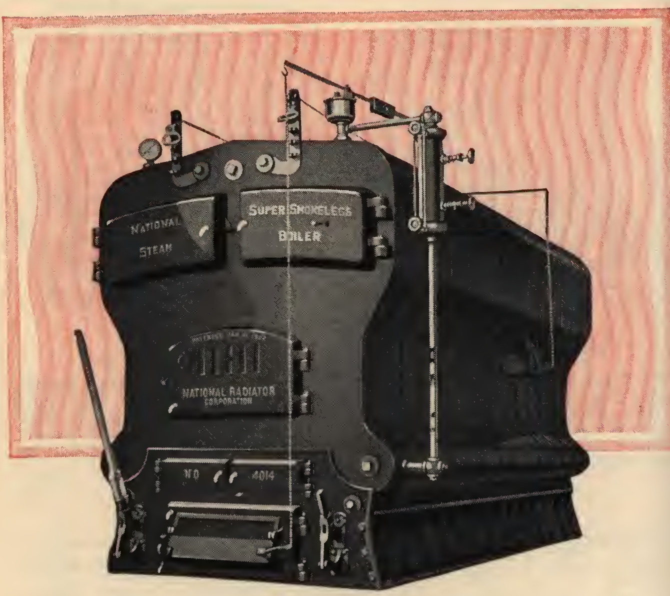
Boiler Number	1	2	3	4	5	6	7	8	9	10	Shaking Grates Left	Shaking Grates Right
S-335	F	L	HT°	AU	B						2	2
S-336	F	LT°	L	HT°	AU	B					3	2
S-337	F	LT°	L	L	HT°	AU	B				3	3
S-338	F	LT°	L	L	HT°	H	AU	B			4	3
S-339	F	LT°	L	L	HT°	H	A	WT°	B		4	4
S-3310	F	LT°	L	L	HT°	H	H	A	WT°	B	5	4

Water Boilers

Boiler Number	1	2	3	4	5	6	7	8	9	10	Shaking Grates Left	Shaking Grates Right
W-335	F	L	HR°	AU	B						2	2
W-336	F	LT°	L	HR°	AU	B					3	2
W-337	F	LT°	L	L	HR°	AU	B				3	3
W-338	F	LT°	L	L	HR°	H	AU	B			4	3
W-339	F	LT°	L	L	HR°	H	A	WT°	B		4	4
W-3310	F	LT°	L	L	HR°	H	H	A	WT°	B	5	4

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 8¼ inches.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)



National No. S-4014

THE popularity of the National Super-Smokeless is easily apparent even to those unfamiliar with its outstanding qualities, when they learn of its ability to pay for itself through savings. By totally consuming the fuel, it effects economies that soon cancel its cost.

The Series 40 is made in nineteen sizes, and is bonded to heat from 2300 to 10,700 square feet of steam radiation and from 3795 to 17,655 square feet of water radiation.

Primary . . .

reasons for secondary air

THE oxygen contained in 14 pounds of air is required to properly consume one pound of coal. However, only seven pounds of this air can be obtained and properly utilized through the fuel bed. Increasing the amount, by increasing the draft, merely makes the coal burn faster, and does not increase the amount of air available to each pound of coal.

The necessary additional seven pounds must be furnished *over* the fuel bed, and in a certain, scientifically developed manner, or it will defeat its own purpose.

The air must be pre-heated. This is accomplished in the National Super-Smokeless by passing it through the patented baffle section which is exposed to the hot flames. The air must be mixed intimately with the hot gases. This is accomplished by delivering it in fine, high velocity jets, distributed across the whole width of the fire box. The additional oxygen in the pre-heated air causes the gases to burn at exceedingly high temperatures. This combustion takes place in the secondary combustion chamber, where there is a large amount of overhanging direct fire surface to absorb the intense heat.

National No. S-4017 Interior View

Two-stage combustion eliminates smoke, boosts efficiency, in burning any kind of fuel. The internal construction of the 33 series Super-Smokeless boiler is practically identical with the 40 series illustrated above, the only difference being the smaller grate width. Complete data and dimensions, No. 33 series on pages 97 and 100; No. 40 Series, pages 108-9 and 111.

Efficiency . . .

and its how and why

(Figures refer to corresponding figures on interior view of coal-burning boiler on page 104.)

1. *The Primary Combustion Chamber,* into the front of which the fresh coal is supplied, and in which the rich, oily volatile gases are distilled from the green fuel.

2. *Bridgewall Section* which is furnished in boilers having 13 or more sections. This section backs up the fuel bed in long boilers.

3. *Hot Blast Duct* which, for each pound of coal burned, supplies to the volatile gases seven pounds of pre-heated air in fine jets.

4. *Water Curtain or Baffle* which protects the hot blast duct, insures its long life, and properly checks the gases in their passage from primary to secondary combustion chamber.

Figures refer to corresponding figures on interior view of coal burning boiler on page 104.

5. *The Gases* here pass from the Primary into the Secondary combustion chamber, and at this point the additional oxygen essential to complete combustion is supplied.

6. *The Secondary Combustion Chamber* in which the combustion of the gases is completed. In this chamber a gas temperature is obtained higher than has hitherto been possible in any similar type of boiler.

7. *Overhanging Fire Surface* extending downward into the hottest part of the combustion zone—extremely valuable heating surface which helps to boost efficiency.

8. *Rotative Gas Travel*—Note carefully the long, forward-and-back, swirling travel of the hot gases—an *exclusive* SUPER-SMOKELESS feature. This scouring effect results in bringing a much larger portion of the gases in contact with the flueway surfaces than is possible in the straight direct gas travel of the ordinary boiler. The result is greater heat transfer to the water, a reduction in stack loss, and higher efficiency.

Standards . . .

of workmanship reflected in performance

THE uniformly dependable, trouble-free service rendered by the National Super-Smokeless Boiler is explained in a phrase—"Controlled Manufacturing Processes."

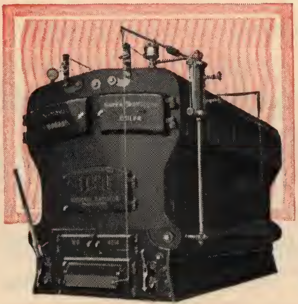
Control that starts with the raw material, when each cast of metal is thoroughly analyzed; that continues through the entire process of manufacture. Control that rigidly rejects any section showing flaws or defects, or failing to pass the rigorous test, where a hydrostatic pressure four times that for which the boiler is designed is applied. Control that applies to every machining and finishing process, holding the tolerance to the smallest fraction of an inch.

Control that extends even to the selection and inspection of the fittings, assuring that each and all will function dependably and accurately.

The careful workmanship of the Super-Smokeless Boiler is reflected in the ease with which it can be set up on the job to form a steam and water tight, permanently effective, unit; is reflected in the economical, efficient service which has made its performance noteworthy wherever it has been used.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)



Series No. 40—
Sizes and Ratings
For Steam and Vapor

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
S-406	5,200	2,300	12.03	2-5″	2-4″	16 x 16	50	56
S-407	6,200	2,800	14.38	3-5″	2-4″	18 x 18	50	66
S-408	7,200	3,300	16.73	3-5″	2-4″	18 x 18	55	76
S-409	8,200	3,800	19.08	3-5″	2-4″	20 x 20	55	86
S-4010	9,200	4,300	21.43	3-5″	2-4″	20 x 20	60	96
S-4011	10,200	4,800	23.77	3-5″	2-4″	21 x 21	60	106
S-4012	11,200	5,300	21.43	4-5″	2-4″	22 x 22	65	116
S-4013	12,200	5,800	21.43	4-5″	2-4″	22 x 22	70	126
S-4014	13,000	6,300	23.77	4-5″	2-4″	23 x 23	75	136
S-4015	13,800	6,800	23.77	4-5″	2-4″	23 x 23	75	146
S-4016	14,600	7,300	23.77	4-5″	2-4″	24 x 24	80	156
S-4017	15,400	7,800	23.77	4-5″	2-4″	24 x 24	80	166
S-4018	16,200	8,300	23.77	4-5″	2-4″	25 x 25	80	176
S-4019	17,000	8,700	23.77	5-5″	2-4″	25 x 25	85	186
S-4020	17,600	9,100	23.77	5-5″	2-4″	25 x 25	90	196
S-4021	18,200	9,500	23.77	5-5″	2-4″	25 x 25	100	206
S-4022	18,800	9,900	23.77	6-5″	2-4″	26 x 26	100	216
S-4023	19,400	10,300	23.77	6-5″	2-4″	27 x 27	100	226
S-4024	20,000	10,700	23.77	6-5″	2-4″	27 x 27	100	236

† Square feet of exterior boiler surface.

Approximately 67 pounds of insulation per section required to provide boiler covering 1½ inches thick.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)

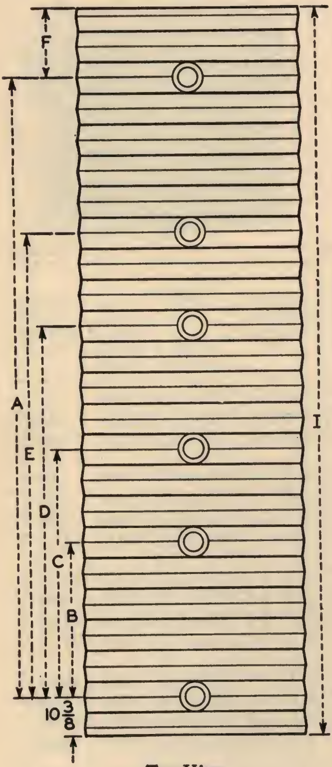
Series No. 40—
Sizes and Ratings
For Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

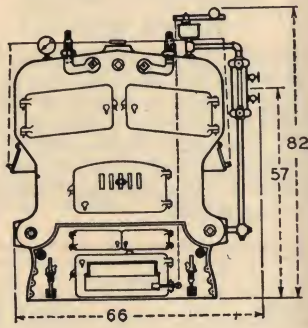
Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets No. and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
W-406	8,300	3,795	12.03	2-5″	2-4″ 2-5″	16 x 16	50	56
W-407	9,900	4,620	14.38	3-5″	2-4″ 2-5″	18 x 18	50	66
W-408	11,500	5,445	16.73	3-5″	2-4″ 2-5″	18 x 18	55	76
W-409	13,100	6,270	19.08	3-5″	2-4″ 2-5″	20 x 20	55	86
W-4010	14,700	7,095	21.43	3-5″	2-4″ 2-5″	20 x 20	60	96
W-4011	16,300	7,920	23.77	3-5″	2-4″ 2-5″	21 x 21	60	106
W-4012	17,900	8,745	21.43	4-5″	2-4″ 4-5″	22 x 22	65	116
W-4013	19,500	9,570	21.43	4-5″	2-4″ 4-5″	22 x 22	70	126
W-4014	20,800	10,395	23.77	4-5″	2-4″ 4-5″	23 x 23	75	136
W-4015	22,100	11,220	23.77	4-5″	2-4″ 4-5″	23 x 23	75	146
W-4016	23,400	12,045	23.77	4-5″	2-4″ 4-5″	24 x 24	80	156
W-4017	24,700	12,870	23.77	4-5″	2-4″ 4-5″	24 x 24	80	166
W-4018	26,000	13,695	23.77	4-5″	2-4″ 4-5″	25 x 25	80	176
W-4019	27,300	14,355	23.77	5-5″	2-4″ 4-5″	25 x 25	85	186
W-4020	28,200	15,015	23.77	5-5″	2-4″ 4-5″	25 x 25	90	196
W-4021	29,200	15,675	23.77	5-5″	2-4″ 4-5″	25 x 25	100	206
W-4022	30,200	16,335	23.77	6-5″	2-4″ 6-5″	26 x 26	100	216
W-4023	31,200	16,995	23.77	6-5″	2-4″ 6-5″	27 x 27	100	226
W-4024	32,200	17,655	23.77	6-5″	2-4″ 6-5″	27 x 27	100	236

† Square feet of exterior boiler surface.
Approximately 67 pounds of insulation per section required to provide boiler covering 1½ inches thick.

Series No. 40—Steam and Water Dimensions



Top View



Supply Outlet Tappings: Boiler sections having outlet tappings are indicated by (°) after key letter, in Standard Assembly of Boiler Sections shown on page 112. Distance from center of one section to center of section next to it is 8¼ inches.

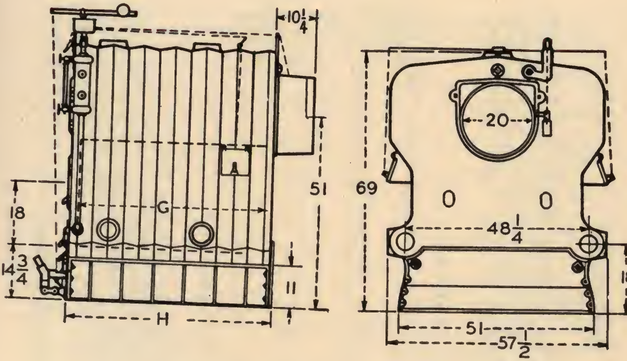
Steam Return Inlet Tappings: Two 4″ in rear of back section "B". Side return inlets on steam boilers are only furnished on special order.

Water Return Inlet Tappings: Two 4″ in rear of back section "B". Additional 5″ return inlets on both sides of each intermediate supply section "HR" and "LR."

Indirect External Water Heater Tapping: One 2 inch tapping located in rear of back boiler section. Bosses for additional 1½ inch tappings located on both sides of all intermediate sections on line with lower gauge cock tapping can be furnished. See current trade price sheet for charge for additional tappings.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)



Series No. 40
Steam and Water Dimensions

Boiler Number	A	B	C	D	E	F	G	H	I
406	24¾	....	....	.....	.....	10⅜	40¾	47	45½
407	33	16½	....	.....	.....	10⅜	49	55¼	53¾
408	41¼	16½	....	.....	.....	10⅜	57¼	63½	62
409	49½	24¾	....	.....	.....	10⅜	65½	71¾	70¼
4010	57¾	33	....	.....	.....	10⅜	73¾	80	78½
4011	57¾	33	....	.....	.....	18⅝	82	88¼	86¾
4012	74¼	33	57¾	.....	.....	10⅜	73¾	96½	95
4013	74¼	33	57¾	.....	.....	18⅝	73¾	104¾	103¼
4014	82½	41¼	66	.....	.....	18⅝	82	113	111½
4015	90¾	41¼	66	.....	.....	18⅝	82	121¼	119¾
4016	99	41¼	66	.....	.....	18⅝	82	129½	128
4017	107¼	41¼	66	.....	.....	18⅝	82	137¾	136¼
4018	115½	41¼	66	.....	.....	18⅝	82	146	144½
4019	123¾	41¼	66	99	.....	18⅝	82	154¼	152¾
4020	132	41¼	66	99	.....	18⅝	82	162½	161
4021	140¼	41¼	66	99	.....	18⅝	82	170¾	169¼
4022	148½	41¼	66	99	123¾	18⅝	82	179	177½
4023	156¾	41¼	66	99	123¾	18⅝	82	187¼	185¾
4024	165	41¼	66	99	123¾	18⅝	82	195½	194

Measurements subject to slight variations in assembly.

Series No. 40
Standard Assembly of Boiler Sections

F—Front; **XT°**—Low crown intermediate, crossover flue next to front, supply outlet, no return inlet; **L**—Low crown intermediate, plain; **LT°**—Low crown intermediate, supply outlet, no return inlet; **H**—High crown intermediate, plain; **HT°**—High crown intermediate, supply outlet, no return inlet; **A**—Baffle, air gates, plain; **K**—Bridgewall; **UT°**—Low crown intermediate, half-uptake, supply outlet, no return inlet; **W**—Low crown intermediate, full-uptake, plain; **WT°**—Low crown intermediate, full-uptake, supply outlet, no return inlet; **B**—Back, 2 return inlets on rear.

Arrangement of Sections—Steam Boilers

Boiler No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shaking Grates L	Shaking Grates R
S-406	F	HT°	L	A	UT°	B																			3	2
S-407	F	XT°	L	HT°	A	UT°	B																		3	3
S-408	F	XT°	L	HT°	H	A	UT°	B																	4	3
S-409	F	XT°	L	L	HT°	H	A	WT°	B																4	4
S-4010	F	XT°	L	L	H	HT°	H	A	WT°	B															5	4
S-4011	F	XT°	L	L	H	HT°	H	A	UT°	W	B														6	4
S-4012	F	XT°	L	L	H	HT°	H	A	HT°	K	WT°	B													5	4
S-4013	F	XT°	L	L	H	HT°	H	A	HT°	K	UT°	W	B												5	4
S-4014	F	XT°	L	L	L	H	HT°	H	A	HT°	K	WT°	W	B											6	4
S-4015	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	WT°	W	B										6	4
S-4016	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	WT°	W	B									6	4
S-4017	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	L	WT°	W	B								6	4
S-4018	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	L	L	WT°	W	B							6	4
S-4019	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	LT°	L	L	WT°	W	B						6	4
S-4020	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	LT°	L	L	L	WT°	W	B					6	4
S-4021	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	LT°	L	L	L	L	WT°	W	B				6	4
S-4022	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	LT°	L	L	LT°	L	L	WT°	W	B			6	4
S-4023	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	LT°	L	L	LT°	L	L	L	WT°	W	B		6	4
S-4024	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	LT°	L	L	LT°	L	L	L	L	WT°	W	B	6	4

(°) after key letter indicates section has supply outlet tapping.
Center to center distance between sections is 8¼ inches.

Series No. 40
Standard Assembly of Boiler Sections

F—Front; XT°—Low crown intermediate, crossover flue next to front, supply outlet, no return inlet; L—Low crown intermediate, plain; LT°—Low crown intermediate, supply outlet, no return inlet; LR°—Low crown intermediate, supply outlet, 2 return inlets (1 on each side); H—High crown intermediate, plain; HR°—High crown intermediate, supply outlet, 2 return inlets (1 on each side); A—Baffle, air gates, plain; K—Bridgewall; UT°—Low crown intermediate, half-uptake, supply outlet, no return inlet; W—Low crown intermediate, full-uptake, plain; WT°—Low crown intermediate, full-uptake, supply outlet, no return inlet; B—Back, 2 return inlets on rear.

Arrangement of Sections—Water Boilers

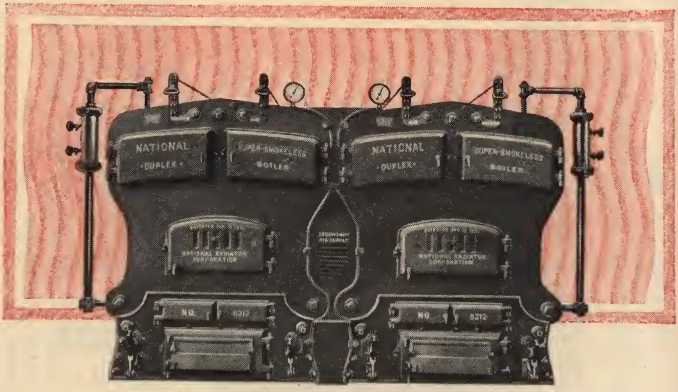
Boiler No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	Shaking Grates L	Shaking Grates R
W-406	F	HR°	L	A	UT°	B																			3	2
W-407	F	XT°	L	HR°	A	UT°	B																		3	3
W-408	F	XT°	L	HR°	H	A	UT°	B																	4	3
W-409	F	XT°	L	L	HR°	H	A	WT°	B																4	4
W-4010	F	XT°	L	L	H	HR°	H	A	WT°	B															5	4
W-4011	F	XT°	L	L	H	HR°	H	A	UT°	W	B														6	4
W-4012	F	XT°	L	L	H	HR°	H	A	HR°	K	WT°	B													5	4
W-4013	F	XT°	L	L	H	HR°	H	A	HR°	K	UT°	W	B												5	4
W-4014	F	XT°	L	L	L	H	HR°	H	A	HR°	K	WT°	W	B											6	4
W-4015	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	WT°	W	B										6	4
W-4016	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	WT°	W	B									6	4
W-4017	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	L	WT°	W	B								6	4
W-4018	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	L	L	WT°	W	B							6	4
W-4019	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	LT°	L	L	WT°	W	B						6	4
W-4020	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	LT°	L	L	L	WT°	W	B					6	4
W-4021	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	LT°	L	L	L	L	WT°	W	B				6	4
W-4022	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	LT°	L	L	LR°	L	L	WT°	W	B			6	4
W-4023	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	LT°	L	L	LR°	L	L	L	WT°	W	B		6	4
W-4024	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	LT°	L	L	LR°	L	L	L	L	WT°	W	B	6	4

(°) after key letter indicates section has supply outlet tapping.

Center to center distance between sections 8¼ inches.

Multiple . . .

advantages — combined in a single unit



NATIONAL SUPER-SMOKELESS DUPLEX BOILER—FRONT VIEW
A flexible and responsible unit, particularly responsive to varying loads. The water line is exceptionally low.

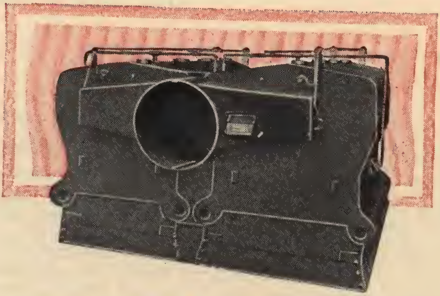
THEORETICALLY, the size of a boiler could be increased indefinitely; actually, too great a size brings disadvantages. For large installations, therefore, the National Super-Smokeless Duplex Boiler is recommended.

The Duplex requires a smaller stack than would a single boiler with the same capacity. It is more econom-

ical; in mild weather one unit can be operated at its peak efficiency, the other standing idle, instead of operating a large single unit at inefficient fractional loads.

The Duplex has advantages over two detached boilers, also, as it saves space, and insulation.

All of the valuable features of the single unit Super-



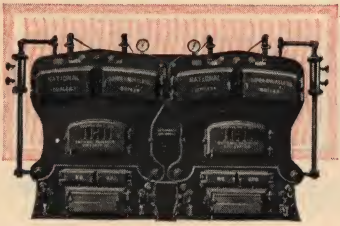
NATIONAL SUPER-SMOKELESS DUPLEX BOILER—REAR VIEW
The above illustration shows the single outlet smoke box which is standard equipment on all Duplex Boilers. Individual smoke boxes for each unit in the Duplex will be furnished on order.

Smokeless are retained. Provision is made for individual control of the secondary air intakes from the front of the boiler.

Like the Super-Smokeless, the Duplex will burn any kind of fuel efficiently, and is particularly well adapted for oil and gas burning because of the large prime heating surface, the progressive increase in combustion area, and the long rotative fire travel.

NATIONAL BONDED SUPER-SMOKELESS BOILERS

(Utica Design)



Duplex Series No. 82

Sizes and Ratings
For Steam and Vapor

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
S-827	13,200	6,300	28.76	6-5″	4-4″	23 x 23	60	90
S-828	15,200	7,300	33.46	6-5″	4-4″	24 x 24	65	104
S-829	17,200	8,300	38.16	6-5″	4-4″	25 x 25	65	118
S-8210	19,200	9,300	42.86	6-5″	4-4″	26 x 26	70	132
S-8211	21,200	10,300	47.54	6-5″	4-4″	27 x 27	70	146
S-8212	23,200	11,300	42.86	8-5″	4-4″	28 x 28	75	160
S-8213	25,200	12,300	42.86	8-5″	4-4″	29 x 29	80	174
S-8214	26,800	13,300	47.54	8-5″	4-4″	29 x 29	85	188
S-8215	28,400	14,300	47.54	8-5″	4-4″	30 x 30	85	202
S-8216	30,000	15,300	47.54	8-5″	4-4″	31 x 31	90	216
S-8217	31,600	16,300	47.54	8-5″	4-4″	32 x 32	90	230
S-8218	33,200	17,300	47.54	8-5″	4-4″	32 x 32	90	244

† Square feet of exterior boiler surface.

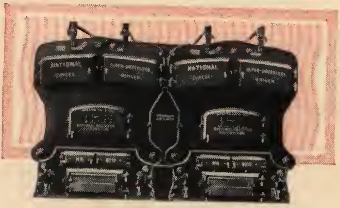
Approximately 94 pounds of insulation per section required to provide boiler covering 1½ inches thick.

100 pounds of insulation will cover approximately 15 square feet of boiler surface to a thickness of 1½ inches.

Headers are not furnished with Super-Smokeless Duplex Boilers.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)

Duplex Series No. 82
Sizes and Ratings
For Hot Water



THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
W-827	21,100	10,400	28.76	6-5″	4-4″ 2-5″	23 x 23	60	90
W-828	24,300	12,050	33.46	6-5″	4-4″ 2-5″	24 x 24	65	104
W-829	27,500	13,700	38.16	6-5″	4-4″ 2-5″	25 x 25	65	118
W-8210	30,700	15,350	42.86	6-5″	4-4″ 2-5″	26 x 26	70	132
W-8211	33,900	17,000	47.54	6-5″	4-4″ 2-5″	27 x 27	70	146
W-8212	37,100	18,650	42.86	8-5″	4-4″ 4-5″	28 x 28	75	160
W-8213	40,300	20,300	42.86	8-5″	4-4″ 4-5″	29 x 29	80	174
W-8214	42,900	21,950	47.54	8-5″	4-4″ 4-5″	29 x 29	85	188
W-8215	45,500	23,600	47.54	8-5″	4-4″ 4-5″	30 x 30	85	202
W-8216	48,100	25,250	47.54	8-5″	4-4″ 4-5″	31 x 31	90	216
W-8217	50,700	26,900	47.54	8-5″	4-4″ 4-5″	32 x 32	90	230
W-8218	53,300	28,550	47.54	8-5″	4-4″ 4-5″	32 x 32	90	244

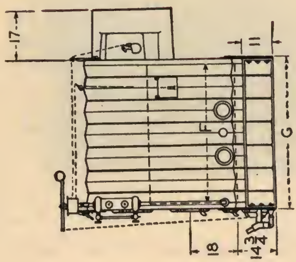
† Square feet of exterior boiler surface.

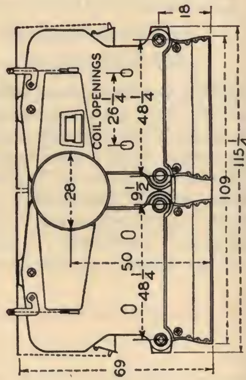
Approximately 94 pounds of insulation per section required to provide boiler covering 1½ inches thick.

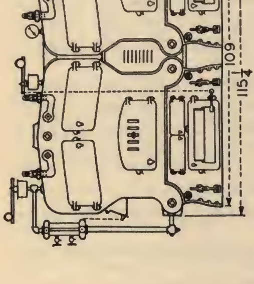
100 pounds of insulation will cover approximately 15 square feet of boiler surface to a thickness of 1½ inches.

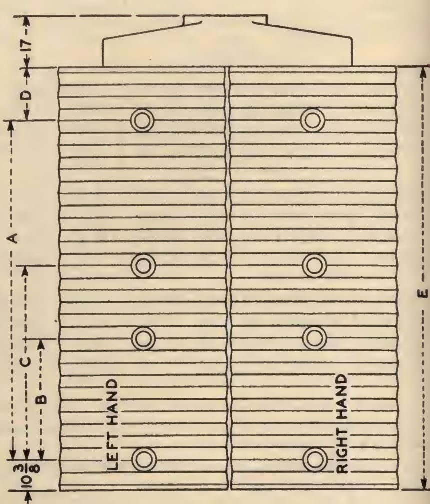
Headers are not furnished with Super-Smokeless Duplex Boilers.

NATIONAL BONDED SUPER-SMOKELESS BOILERS
(Utica Design)









Series No. 82—Steam and Water Dimensions

Boiler Number	A	B	C	D	E	F	G
827	33″	16½″	......	10⅜″	53¾″	49″	55¼″
828	41¼″	16½″	......	10⅜″	62″	57¼″	63½″
829	49½″	24¾″	......	10⅜″	70¼″	65½″	71¾″
8210	57¾″	33″	......	10⅜″	78½″	73¾″	80″
8211	66″	33″	......	18⅝″	86¾″	82″	88¼″
8212	74¼″	33″	57¾″	10⅜″	95″	73¾″	96½″
8213	74¼″	33″	57¾″	18⅝″	103¼″	73¾″	104¾″
8214	82½″	41¼″	66″	18⅝″	111½″	82″	113″
8215	90¾″	41¼″	66″	18⅝″	119¾″	82″	121¼″
8216	99″	41¼″	66″	18⅝″	128″	82″	129½″
8217	107¼″	41¼″	66″	18⅝″	136¼″	82″	137¾″
8218	115½″	41¼″	66″	18⅝″	144½″	82″	146″

Measurements subject to slight variations in assembly.
Ashpit and foundation measurements are given on page 123.

Series No. 82

Standard Assembly of Boiler Sections

F—Front; **XT°**—Low crown intermediate, crossover flue next to front, supply outlet, no return inlet; **L**—Low crown intermediate, plain; **H**—High crown intermediate, plain; **HT°**—High crown intermediate, supply outlet, no return inlet; **A**—Baffle, air gates, plain; **K**—Bridgewall; **UT°**—Low crown intermediate, half-uptake, supply outlet, no return inlet; **W**—Low crown intermediate, full-uptake, plain; **WT°**—Low crown intermediate, full-uptake, supply outlet, no return inlet; **B**—Back, 2 return inlets on rear.

Arrangement of Sections—Steam Boilers

Boiler Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
S-827	Left Half	F	XT°	L	HT°	A	UT°	B											
	Right Half	F	XT°	L	HT°	A	UT°	B											
S-828	Left Half	F	XT°	L	HT°	H	A	UT°	B										
	Right Half	F	XT°	L	HT°	H	A	UT°	B										
S-829	Left Half	F	XT°	L	L	HT°	H	A	WT°	B									
	Right Half	F	XT°	L	L	HT°	H	A	WT°	B									
S-8210	Left Half	F	XT°	L	L	H	HT°	H	A	WT°	B								
	Right Half	F	XT°	L	L	H	HT°	H	A	WT°	B								
S-8211	Left Half	F	XT°	L	L	H	HT°	H	A	UT°	W	B							
	Right Half	F	XT°	L	L	H	HT°	H	A	UT°	W	B							
S-8212	Left Half	F	XT°	L	L	H	HT°	H	A	HT°	K	WT°	B						
	Right Half	F	XT°	L	L	H	HT°	H	A	HT°	K	WT°	B						
S-8213	Left Half	F	XT°	L	L	H	HT°	H	A	HT°	K	UT°	W	B					
	Right Half	F	XT°	L	L	H	HT°	H	A	HT°	K	UT°	W	B					
S-8214	Left Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	WT°	W	B				
	Right Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	WT°	W	B				
S-8215	Left Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	WT°	W	B			
	Right Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	WT°	W	B			
S-8216	Left Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	WT°	W	B		
	Right Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	WT°	W	B		
S-8217	Left Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	L	WT°	W	B	
	Right Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	L	WT°	W	B	
S-8218	Left Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	L	L	WT°	W	B
	Right Half	F	XT°	L	L	L	H	HT°	H	A	HT°	K	H	L	L	L	WT°	W	B

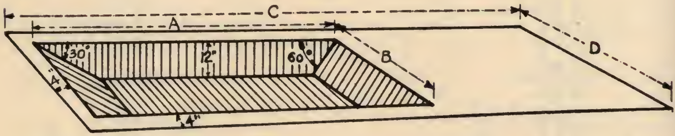
Series No. 82
Standard Assembly of Boiler Sections

F—Front; XT°—Low crown intermediate, crossover flue next to front, supply outlet, no return inlet; L—Low crown intermediate, plain; H—High crown intermediate, plain; HR°—High crown intermediate, supply outlet, 2 return inlets (1 on each side); A—Baffle, air gates, plain; K—Bridgewall; UT°—Low crown intermediate, half-uptake, supply outlet, no return inlet; W—Low crown intermediate, full-uptake, plain; WT°—Low crown intermediate. full-uptake, supply outlet, no return inlet; B—Back, 2 return inlets on rear.

Arrangement of Sections—Water Boilers

Boiler Number		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
W-827	Left Half	F	XT°	L	HR°	A	UT°	B											
	Right Half	F	XT°	L	HR°	A	UT°	B											
W-828	Left Half	F	XT°	L	HR°	H	A	UT°	B										
	Right Half	F	XT°	L	HR°	H	A	UT°	B										
W 829	Left Half	F	XT°	L	L	HR°	H	A	WT°	B									
	Right Half	F	XT°	L	L	HR°	H	A	WT°	B									
W-8210	Left Half	F	XT°	L	L	H	HR°	H	A	WT°	B								
	Right Half	F	XT°	L	L	H	HR°	H	A	WT°	B								
W-8211	Left Half	F	XT°	L	L	H	HR°	H	A	UT°	W	B							
	Right Half	F	XT°	L	L	H	HR°	H	A	UT°	W	B							
W-8212	Left Half	F	XT°	L	L	H	HR°	H	A	HR°	K	WT°	B						
	Right Half	F	XT°	L	L	H	HR°	H	A	HR°	K	WT°	B						
W-8213	Left Half	F	XT°	L	L	H	HR°	H	A	HR°	K	UT°	W	B					
	Right Half	F	XT°	L	L	H	HR°	H	A	HR°	K	UT°	W	B					
W-8214	Left Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	WT°	W	B				
	Right Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	WT°	W	B				
W-8215	Left Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	WT°	W	B			
	Right Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	WT°	W	B			
W-8216	Left Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	WT°	W	B		
	Right Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	WT°	W	B		
W-8217	Left Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	L	WT°	W	B	
	Right Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	L	WT°	W	B	
W-8218	Left Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	L	L	WT°	W	B
	Right Half	F	XT°	L	L	L	H	HR°	H	A	HR°	K	H	L	L	L	WT°	W	B

Foundation and Pitting Dimensions
Series No. 24, 33 and 40

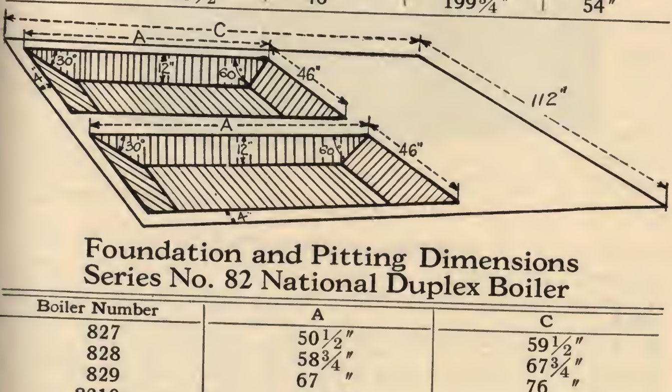


The tables below give all the necessary measurements for pitting the National Super-Smokeless Boiler. Letters refer to corresponding letters on the diagram.

Boiler Number	Measurements of Pit Under Ash Pit		Dimensions of Foundation	
	A	B	C	D
Series No. 24 National Super-Smokeless Boiler				
245	34 "	24"	43 "	32"
246	42¼"	24"	51¼"	32"
247	50½"	24"	59½"	32"
248	58¾"	24"	67¾"	32"
249	67 "	24"	76 "	32"
Series No. 33 National Super-Smokeless Boiler				
335	34 "	33½"	43 "	41½"
336	42¼"	33½"	51¼"	41½"
337	50½"	33½"	59½"	41½"
338	58¾"	33½"	67¾"	41½"
339	67 "	33½"	76 "	41½"
3310	75¼"	33½"	84¼"	41½"
Series No. 40 National Super-Smokeless Boiler				
406	42¼"	46"	51¼"	54"
407	50½"	46"	59½"	54"
408	58¾"	46"	67¾"	54"
409	67 "	46"	76 "	54"
4010	75¼"	46"	84¼"	54"
4011	83½"	46"	92½"	54"
4012	75¼"	46"	100¾"	54"
4013	75¼"	46"	109 "	54"
4014	83½"	46"	117¼"	54"

Foundation and Pitting Dimensions
Series No. 40 National Super-Smokeless Boiler (continued)

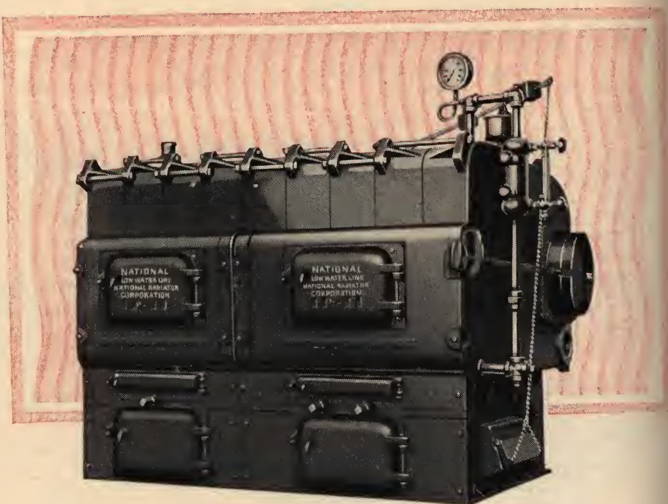
Boiler Number	Measurements of Pit Under Ash Pit		Dimensions of Foundation	
	A	B	C	D
4015	83½″	46″	125½″	54″
4016	83½″	46″	133¾″	54″
4017	83½″	46″	142 ″	54″
4018	83½″	46″	150¼″	54″
4019	83½″	46″	158½″	54″
4020	83½″	46″	166¾″	54″
4021	83½″	46″	175 ″	54″
4022	83½″	46″	183¼″	54″
4023	83½″	46″	191½″	54″
4024	83½″	46″	199¾″	54″



Foundation and Pitting Dimensions
Series No. 82 National Duplex Boiler

Boiler Number	A	C
827	50½″	59½″
828	58¾″	67¾″
829	67 ″	76 ″
8210	75¼″	84¼″
8211	83½″	92½″
8212	75¼″	100¾″
8213	75¼″	109 ″
8214	83½″	117¼″
8215	83½″	125½″
8216	83½″	133¾″
8217	83½″	142 ″
8218	83½″	150¼″

When boiler is erected before basement floor is laid, surround pit with foundation 10 to 12 inches wide.



National No. 39-S

NATIONAL Low Water Line Boilers are often the only, and always the best, solution when insufficient head room is the problem. They are particularly well adapted to theatre work, and to buildings where the installation of an ordinary boiler would make an expensive pit necessary.

The Series No. 30 is made in eight sizes, and is bonded to heat from 850 to 2600 square feet of steam radiation, and from 1400 to 4305 square feet of water radiation.

Digging . . .

into a problem instead of a floor

NATIONAL Low Water Line Boilers save thousands of dollars in building construction by eliminating necessity for pits and high boiler room ceilings.

In tide water country where deep basements are impractical, and in buildings elsewhere where head room is at a premium, the National Low Water Line Boiler is a welcome solution to a difficult problem. Without any sacrifice of efficiency, it provides ample distance between water line and low point of main that assures proper steam circulation, and guards against the danger of boiler breakage.

One of the common causes of trouble at the ends of steam mains and dry returns is insufficient distance between the normal water line of the boiler and the ends of the main to take care of the inequality in pressure in the heating system. This is particularly true in vapor systems, many of which are designed to operate on a few ounces of pressure. (See page 350).

The grate bars shake in batteries of two or three, so that any portion of the fire can be cleaned without disturbing the rest. Connecting yokes are on the outside at the rear, therefore any grate bar may be removed in case of accident without crawling inside the fire box, or the ash pit.

National No. 38-S Interior View

THIS interior view admirably illustrates the reasons for the high efficiency of this outstanding boiler. The maze of water legs provide a large amount of prime heating surface, and at the same time break the water up into small columns, speeding the heat transfer. A special feature is the circulation, which is so controlled that the hottest gases come in contact with the hottest water.

Complete data and dimensions on pages 128 and 129.

Efficient . . .

with all fuels, at all seasons

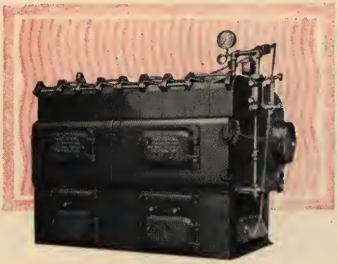
FIRING the National Low Water Line Boiler is easy, for the coal is thrown on the short way of the grate. Since the maximum distance is only 40 inches in the largest boiler, only about 4 feet of clearance is needed between boiler front, and boiler room wall. Often the design of the boiler room is such that a side feed boiler can be more conveniently fired than an end feed boiler. In this situation, a National Low Water Line Boiler excels.

In mild weather, a portion of the grate can be banked with ashes, and only the remaining portion used. The fuel that is used can thus be fired at the proper depth, and burned at the proper rate, to yield maximum efficiency.

The large proportion of prime heating surface, and its location, and design, makes this boiler a quick steamer, readily and quickly adaptable to varying load demands. The boilers are easily adaptable to oil burning operations. The burner is installed in the base end, usually at the smoke-pipe end of the boiler. Several of the ports between sections at the opposite end of the boiler should be filled with fire clay to force the burning gases back to the burner end of the fire box before they are allowed to pass into the first flue way. Sketches showing the suggested method of installation will be supplied on request.

NATIONAL BONDED LOW WATER LINE BOILERS

(Hard Coal Type)



Series No. 30
Sizes and Ratings
For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
Steam								
35-S	1,700	850	5.83	2-4″	2-4″	12 x 12	40	42
36-S	2,200	1,100	7.29	2-4″	2-4″	12 x 12	40	46
37-S	2,700	1,350	8.75	2-4″	2-4″	12 x 12	40	51
38-S	3,200	1,600	10.21	2-4″	2-4″	12 x 12	40	56
39-S	3,700	1,850	11.67	2-4″	2-4″	12 x 16	45	60
310-S	4,200	2,100	13.13	2-4″	2-4″	12 x 16	45	65
311-S	4,700	2,350	14.59	2-4″	2-4″	12 x 16	50	68
312-S	5,200	2,600	16.05	2-4″	2-4″	16 x 16	50	73
Water								
35-W	2,800	1,400	5.83	2-4″	2-4″	12 x 12	40	42
36-W	3,600	1,815	7.29	2-4″	2-4″	12 x 12	40	46
37-W	4,400	2,230	8.75	2-4″	2-4″	12 x 12	40	51
38-W	5,200	2,645	10.21	2-4″	2-4″	12 x 12	40	56
39-W	6,000	3,060	11.67	2-4″	2-4″	12 x 16	45	60
310-W	6,800	3,475	13.13	2-4″	2-4″	12 x 16	45	65
311-W	7,600	3,890	14.59	2-4″	2-4″	12 x 16	50	68
312-W	8,400	4,305	16.05	2-4″	2-4″	16 x 16	50	73

† Square feet of exterior boiler surface.

NATIONAL BONDED LOW WATER LINE BOILERS

(Hard Coal Type)

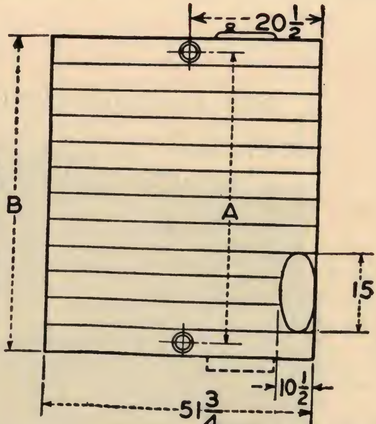
Series No. 30

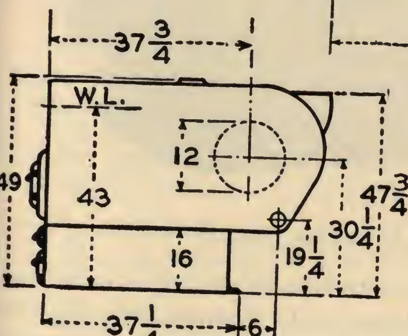
Steam and Water Dimensions

Supply Outlet Tappings: One 4″ outlet in right end section and one 4″ outlet in left end section. No. 30 Series boilers not furnished with intermediate tapped sections.

Return Inlet Tappings: One 4″ inlet in the side of right end section and one 4″ inlet in the side of left end section.

Center to center distance between sections is 7 inches.





Approximately 47 pounds of insulation per section required to provide boiler covering 1½ inches thick.

Indirect Water Heater Tappings: One 2″ tapping located on side of left end section. Boss for additional 2″ tapping located on side of right end section. Additional 1½″ tappings can be furnished on front of intermediate sections.

Smoke Outlet: End Outlet furnished on boilers having up to 10 sections. Rear outlet furnished on longer boilers.

Boiler Numbers		A	B
35-S	35-W	28½″	35″
36-S	36-W	35½″	42″
37-S	37-W	42½″	49″
38-S	38-W	49½″	56″
39-S	39-W	56½″	63″
310-S	310-W	63½″	70″
311-S	311-W	70½″	77″
312-S	312-W	77½″	84″

Measurements subject to slight variations in assembly.
Ashpit and foundation measurements are shown on page 150.
Standard assembly of sections is shown on page 148.

National No. 410-S

THOUSANDS upon thousands of dollars have been saved in construction costs through National Low Water Line Boilers, due to the elimination of refuse gathering pits, and high boiler room ceilings. This unit is a prime favorite in tide water country, and in all buildings where lack of basement head-room is a problem.

The Series 40 illustrated is made in thirteen sizes and is bonded to heat from 1800 to 6600 square feet of steam radiation, and from 2970 to 10,890 square feet of water radiation.

Quality . . .

equipment is the unfailing standard

IN order that National Low Water Line Boilers may, in the smallest details, live up to the enviable reputation that they have earned and enjoy, the accessories are chosen with the greatest care, after tests that conclusively establish their fitness for the work.

Standard equipment on the National Low Water Line Boilers includes an all-metal, all-inclosed damper regulator, of extreme sensitiveness. An A. S. M. E. standard pop safety valve; a Bourdon-tube type retard steam gauge, with siphon and non-glare dial; a gauge glass; tri-cocks; and firing tools.

No accessories are furnished with the water boiler. If they are desired the following assortment is recommended:

An altitude gauge, to indicate the height of water column; a water temperature regulator, sensitive to small temperature changes, but not affected by pressure variations; a thermometer, of the mercury-well type. See accessory section for full descriptions.

Boilers up to ten sections, in both the 30 and 40 series, are regularly equipped with an end smoke box, as shown on page 130. Boilers having eleven sections or more have a rear smoke box, as illustrated and described on page 140.

National No. 413-S Interior View

Interior view showing the maze of water legs, which give amazing efficiency.

Low . . .

water line—
high efficiency

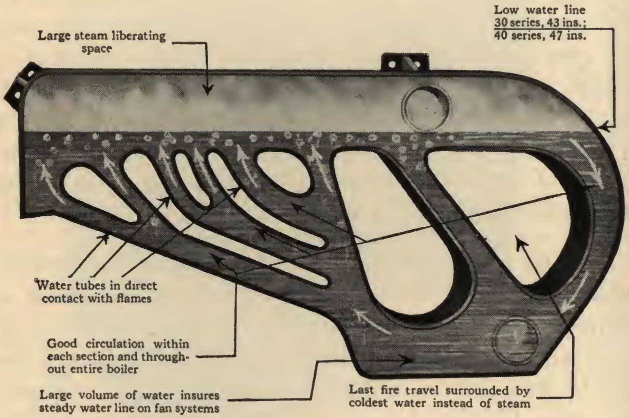
THE ingenious design of the National Low Water Line Boiler permits the placing of water tubes in the fire box where they come in contact with the intense heat of the fire.

The flames completely envelop the tubes; rise to the crown sheet; then pass through section ports to the first flueway, strike the rear wall, swirl, and pass to the end, across the entire length of the boiler, then enter the rear flueway and proceed the entire length of the boiler in the opposite direction before entering the smoke outlet. This unique and efficient path of travel gives the heat of burning gases ample opportunity to be absorbed by the waterways, resulting in effective and economical combustion.

Due to the tube design the water in the boiler is broken up into numerous small columns which are entirely surrounded by fire. For the same reason that a small amount of water in a pan placed over a gas flame can be brought to the boiling point almost instantly, the water in these tubes is quickly brought to a boiling point. The balanced circulation of the water within the boiler prevents priming, maintains a steady water line, and insures the maximum absorption of heat.

Balanced Circulation

AMAZING ingenuity was displayed in the design of the National Low Water Line Boiler. The relatively cold return water is delivered at the back of the boiler where it absorbs heat from the gases in the last flueway. It then progresses towards the front. Here it rises through the branching water legs which are exposed to the hottest part of the fire. The ideal in circulation is thus realized; the hottest water is exposed to the hottest part of the fire, and the coldest water is exposed to the cooler gases. This is a direct reversal of the usual procedure, and is made possible by locating the fire travel back of the fire box instead of above it.



The illustration shows this circulation clearly, and explains how the apparent impossible was accomplished; namely, uniting a low water line with high efficiency operation and balanced circulation.

Carefree . . .

operation — through careful construction

WHEN the National Radiator Corporation was formed, the leading products of each of the six great component companies were retained, and combined to form the Corporation's standard line. With the products were inherited ideals of quality that extend to every manufacturing operation. Metallurgical laboratories are maintained, which analyze all metal going into the boilers, and assure its conformation to the highest standards. Each section is tested at a pressure more than four times as great as the boiler ordinarily will be called upon to carry.

All machining and finishing is done to minute limits, with constant and vigilant checks by competent inspectors. Connections are made by crown taper cast iron push nipples, machined to narrow tolerances, so that the assembly of the boilers on the job will be a quick and easy task, and leaks will be permanently barred.

Doors are ground to an accurate fit on their frames, to prevent infiltration of air.

Every careful step in manufacture assures satisfaction, warrants performance, gives the customer something more, and something better, than he expects.

(Hard Coal Type)

Series No. 40
Sizes and Ratings
For Steam and Vapor

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets No. and Size In.	Chimney		†Covering Surface Sq. Ft
						Area Inches	Height Feet	
46-S	4,100	1,800	9.79	2-5″	2-5″	12 x 16	45	59
47-S	4,900	2,200	11.73	2-5″	2-5″	12 x 16	45	65
48-S	5,700	2,600	13.68	2-5″	2-5″	16 x 16	50	72
49-S	6,500	3,000	15.62	2-5″	2-5″	16 x 20	55	78
410-S	7,300	3,400	17.57	2-5″	2-5″	16 x 20	55	85
411-S	8,100	3,800	19.51	2-5″	2-5″	20 x 20	55	89
412-S	8,900	4,200	21.45	2-5″ 1-4″	2-5″	20 x 20	60	96
413-S	9,700	4,600	23.40	2-5″ 1-4″	2-5″	24 x 24	65	102
414-S	10,500	5,000	25.34	2-5″ 1-4″	2-5″	24 x 24	65	108
415-S	11,300	5,400	27.29	2-5″ 1-4″	2-5″	24 x 28	65	115
416-S	12,100	5,800	29.23	2-5″ 2-4″	2-5″	28 x 28	70	121
417-S	12,900	6,200	31.17	2-5″ 2-4″	2-5″	28 x 28	70	128
418-S	13,700	6,600	33.12	2-5″ 2-4″	2-5″	28 x 32	70	135

† Square feet of exterior boiler surface.

Approximately 57 pounds of insulation per section required to provide boiler covering 1½ inches thick.

100 pounds of insulation will cover approximately 15 square feet of boiler surface to a thickness of 1½ inches.

Supply Outlet Tappings: One 5″ outlet in right end section and one 5″ outlet in left end section. Additional 4″ outlets are furnished in intermediate sections in boilers having 12 or more sections. See dimension table on page 139 for location of intermediate sections with outlets.

Return Inlet Tappings: One 5″ inlet in right end section and one 5″ inlet in left end section.

NATIONAL BONDED LOW WATER LINE BOILERS

(Hard Coal Type)

Series No. 40
Sizes and Ratings
For Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets No. and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
46-W	6,600	2,970	9.79	2-5″	2-5″	12 x 16	45	59
47-W	7,900	3,630	11.73	2-5″	2-5″	12 x 16	45	65
48-W	9,200	4,290	13.68	2-5″	2-5″	16 x 16	50	72
49-W	10,500	4,950	15.62	2-5″	2-5″	16 x 20	55	78
410-W	11,800	5,610	17.57	2-5″	2-5″	16 x 20	55	85
411-W	13,100	6,270	19.51	2-5″	2-5″	20 x 20	55	89
412-W	14,400	6,930	21.45	2-5″ 1-4″	2-5″	20 x 20	60	96
413-W	15,700	7,590	23.40	2-5″ 1-4″	2-5″	24 x 24	65	102
414-W	17,000	8,250	25.34	2-5″ 1-4″	2-5″	24 x 24	65	108
415-W	18,300	8,910	27.29	2-5″ 1-4″	2-5″	24 x 28	65	115
416-W	19,600	9,570	29.23	2-5″ 2-4″	2-5″	28 x 28	70	121
417-W	20,900	10,230	31.17	2-5″ 2-4″	2-5″	28 x 28	70	128
418-W	22,200	10,890	33.12	2-5″ 2-4″	2-5″	28 x 32	70	135

† Square feet of exterior boiler surface.

Approximately 57 pounds of insulation per section required to provide boiler covering 1½ inches thick.

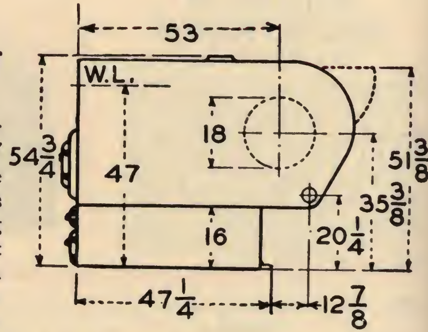
Supply Outlet Tappings: One 5″ outlet in right end section and one 5″ outlet in left end section. Additional 4″ outlets are furnished in intermediate sections in boilers having 12 or more sections. See dimension table on page 139 for location of intermediate sections with outlets.

Return Inlet Tappings: One 5″ inlet in right end section and one 5″ inlet in left end section. Intermediate sections are not furnished with inlet tappings but additional inlet tappings can be furnished on end sections when ordered shipped from point of manufacture.

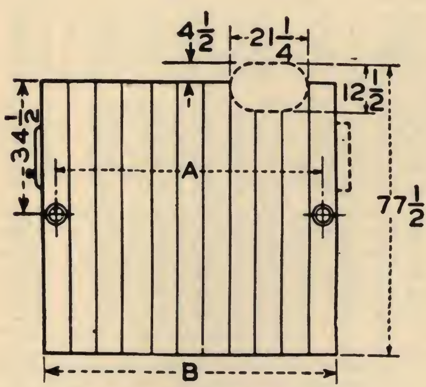
Series No. 40

Steam and Water Dimensions

Indirect External Water Heater Tappings: One 2″ tapping located on side of left end section. Boss for additional 2″ tapping located on side of right end section. Additional 1½″ tappings can be furnished on front of intermediate sections.



End view, showing dimensions.



Top view, 6 to 11 section boiler.

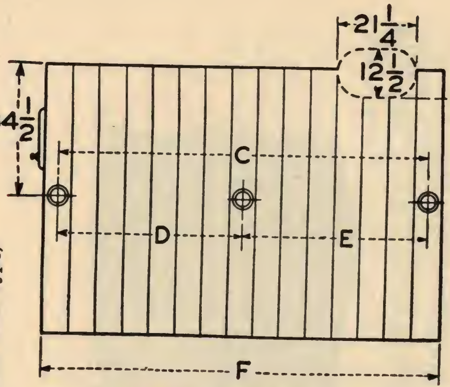
Boiler Number	A	B
46	35½″	42″
47	42½″	49″
48	49½″	56″
49	56½″	63″
410	63½″	70″
411	70½″	77″

Smoke Outlet: End outlet furnished on boilers up to 10 sections. Rear outlet furnished on boilers having 11 or more sections. See page 140.

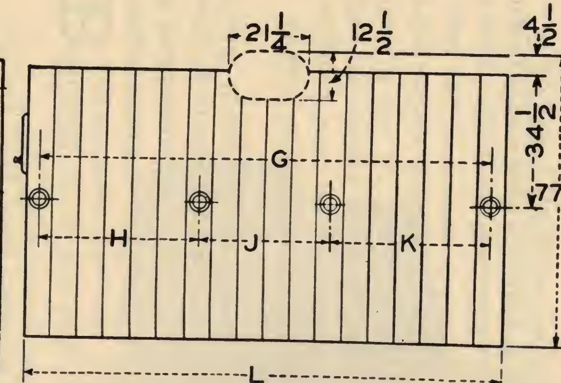
Dimensions of boilers having 12 or more sections are shown on opposite page. Standard assembly of sections is shown on page 149.

NATIONAL BONDED LOW WATER LINE BOILERS

(Hard Coal Type)



Top view, 12 to 15 section boiler.



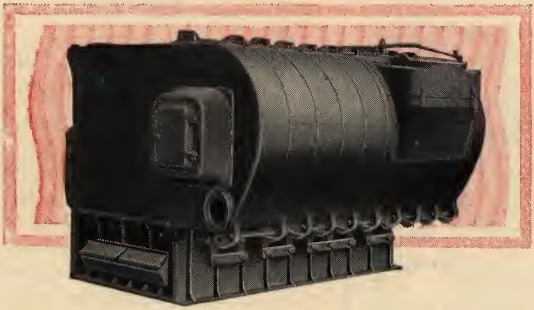
Top view, 16 to 18 section boiler.

Series No. 40—Steam and Water Dimensions

Boiler Number	C	D	E	F
412	77½″	35¼″	42¼″	84″
413	84½″	42¼″	42¼″	91″
414	91½″	42¼″	49¼″	98″
415	98½″	49¼″	49¼″	105″

Boiler Number	G	H	J	K	L
416	105½″	35¼″	35″	35¼″	112″
417	112½″	35¼″	42″	35¼″	119″
418	119½″	42¼″	35″	42¼″	126″

Dimensions subject to slight variations in assembly.
Ash pit and foundation measurements are shown on page 150.



Rear View of National Bonded Low Water Line Boiler Showing Rear Smoke Box.

BOILERS up to ten sections (both Series No. 30 and 40 hard coal and smokeless) are regularly equipped with an end smoke box, as shown on page 130. A rear smoke box can be furnished in boilers having ten sections or less if location of chimney makes it impracticable to use the recommended end smoke box.

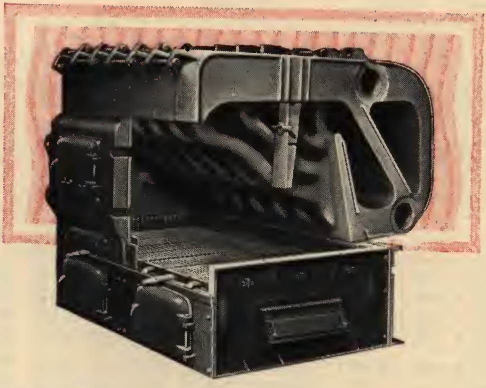
Boilers having eleven or more sections are regularly equipped with a rear smoke box as illustrated above. The rear smoke outlet is formed by cutting out a portion of two or three intermediate sections. Since all intermediate sections are the same, these cut-out sections can be located at the right or left end or in the center, whichever best meets local conditions. Excepting in boilers having sixteen or more sections, either end is preferable to the center location.

Smokeless . . .

Where Ordinances Demand It

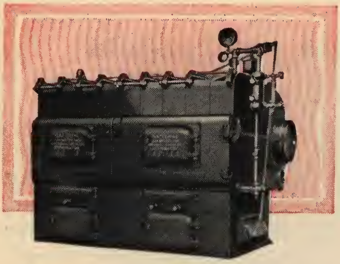
WHILE soft coal at a low rate of combustion may be burned in the Low Water Line Boiler without objectionable smoke, a smokeless low water line boiler has been developed that passes smoke tests when operated at higher rates of combustion.

Specially designed air retorts are placed between the intermediate sections, and supply heated air over the entire length of the fire box. The retorts form a baffle, under which all unconsumed gases must pass, and become thoroughly mixed with the secondary air.



National Low Water Line Smokeless Boilers have passed smoke tests satisfactorily in principal cities throughout the country. All of the outstanding features of the National Low Water Line Hard Coal type are, of course, present.

NATIONAL BONDED LOW WATER LINE BOILERS
(Smokeless Type)



Series No. 30
Sizes and Ratings
For Steam, Vapor and Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets Number and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
Steam								
530-SS	1,700	850	5.83	2-4″	2-4″	12 x 12	40	42
630-SS	2,200	1,100	7.29	2-4″	2-4″	12 x 12	40	46
730-SS	2,700	1,350	8.75	2-4″	2-4″	12 x 12	40	51
830-SS	3,200	1,600	10.21	2-4″	2-4″	12 x 12	40	56
930-SS	3,700	1,850	11.67	2-4″	2-4″	12 x 16	45	60
1030-SS	4,200	2,100	13.13	2-4″	2-4″	12 x 16	45	65
1130-SS	4,700	2,350	14.59	2-4″	2-4″	12 x 16	50	68
1230-SS	5,200	2,600	16.05	2-4″	2-4″	16 x 16	50	73
Water								
530-SW	2,800	1,400	5.83	2-4″	2-4″	12 x 12	40	42
630-SW	3,600	1,815	7.29	2-4″	2-4″	12 x 12	40	46
730-SW	4,400	2,230	8.75	2-4″	2-4″	12 x 12	40	51
830-SW	5,200	2,645	10.21	2-4″	2-4″	12 x 12	40	56
930-SW	6,000	3,060	11.67	2-4″	2-4″	12 x 16	45	60
1030-SW	6,800	3,475	13.13	2-4″	2-4″	12 x 16	45	65
1130-SW	7,600	3,890	14.59	2-4″	2-4″	12 x 16	50	68
1230-SW	8,400	4,305	16.05	2-4″	2-4″	16 x 16	50	73

†Square feet of exterior boiler surface.

NATIONAL BONDED LOW WATER LINE BOILERS

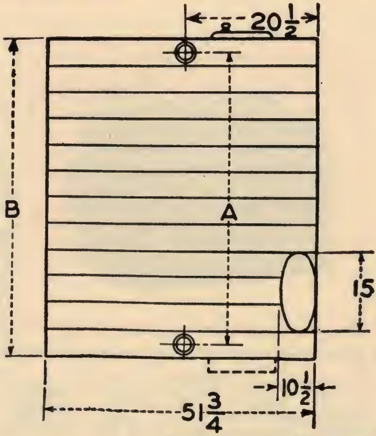
(Smokeless Type)

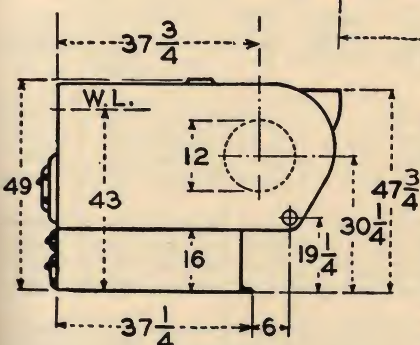
Series No. 30 Steam and Water Dimensions

Supply Outlet Tappings: One 4″ outlet in right end section and one 4″ outlet in left end section. No. 30 Series boilers not furnished with intermediate tapped sections.

Return Inlet Tappings: One 4″ inlet in the side of right end section and one 4″ inlet in the side of left end section.

Center to center distance between sections is 7 inches.





Approximately 47 pounds of insulation per section required to provide boiler covering 1½ inches thick.

Indirect Water Heater Tappings: One 2″ tapping located on side of left end section. Boss for additional 2″ tapping located on side of right end section. Additional 1½″ tappings can be furnished on front of intermediate sections.

Smoke Outlet: End outlet furnished on boilers up to 10 sections. Rear outlet furnished on longer boilers. See page 140.

Boiler Numbers		A	B
530-SS	530-SW	28½″	35″
630-SS	630-SW	35½″	42″
730-SS	730-SW	42½″	49″
830-SS	830-SW	49½″	56″
930-SS	930-SW	56½″	63″
1030-SS	1030-SW	63½″	70″
1130-SS	1130-SW	70½″	77″
1230-SS	1230-SW	77½″	84″

Measurements subject to slight variations in assembly.
Ash pit and foundation measurements are shown on page 150.

NATIONAL BONDED LOW WATER LINE BOILERS

(Smokeless Type)

Series No. 40
Sizes and Ratings
For Steam and Vapor

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers, "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets No. and Size In.	Chimney Area Inches	Chimney Height Feet	†Covering Surface Sq. Ft.
640-SS	4,100	1,800	9.79	2-5″	2-5″	12 x 16	45	59
740-SS	4,900	2,200	11.73	2-5″	2-5″	12 x 16	45	65
840-SS	5,700	2,600	13.68	2-5″	2-5″	16 x 16	50	72
940-SS	6,500	3,000	15.62	2-5″	2-5″	16 x 20	55	78
1040-SS	7,300	3,400	17.57	2-5″	2-5″	16 x 20	55	85
1140-SS	8,100	3,800	19.51	2-5″	2-5″	20 x 20	55	89
1240-SS	8,900	4,200	21.45	2-5″ 1-4″	2-5″	20 x 20	60	96
1340-SS	9,700	4,600	23.40	2-5″ 1-4″	2-5″	24 x 24	65	102
1440-SS	10,500	5,000	25.34	2-5″ 1-4″	2-5″	24 x 24	65	108
1540-SS	11,300	5,400	27.29	2-5″ 1-4″	2-5″	24 x 28	65	115
1640-SS	12,100	5,800	29.23	2-5″ 2-4″	2-5″	28 x 28	70	121
1740-SS	12,900	6,200	31.17	2-5″ 2-4″	2-5″	28 x 28	70	128
1840-SS	13,700	6,600	33.12	2-5″ 2-4″	2-5″	28 x 32	70	135

† Square feet of exterior boiler surface.

Approximately 57 pounds of insulation per section required to provide boiler covering 1½ inches thick.

Supply Outlet Tappings: One 5″ outlet in right end section and one 5″ outlet in left end section. Additional 4″ outlets are furnished in intermediate sections in boilers having 12 or more sections. See dimension table, page 147, for location of intermediate sections with outlets.

Return Inlet Tappings: One 5″ inlet in right end section and one 5″ inlet in left end section.

NATIONAL BONDED LOW WATER LINE BOILERS

(Smokeless Type)

Series No. 40
Sizes and Ratings
For Hot Water

THE number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet." For comparison with similarly rated boilers, "Available Output" ratings are also shown.

Boiler Number	Available Output Rating Sq. Ft.	Bonded Direct C. I. Radiation Sq. Ft.	Grate Area Sq. Ft.	Outlets Number and Size In.	Inlets No. and Size In.	Chimney		†Covering Surface Sq. Ft.
						Area Inches	Height Feet	
640-SW	6,600	2,970	9.79	2-5″	2-5″	12 x 16	45	59
740-SW	7,900	3,630	11.73	2-5″	2-5″	12 x 16	45	65
840-SW	9,200	4,290	13.68	2-5″	2-5″	16 x 16	50	72
940-SW	10,500	4,950	15.62	2-5″	2-5″	16 x 20	55	78
1040-SW	11,800	5,610	17.57	2-5″	2-5″	16 x 20	55	85
1140-SW	13,100	6,270	19.51	2-5″	2-5″	20 x 20	55	89
1240-SW	14,400	6,930	21.45	2-5″ 1-4″	2-5″	20 x 20	60	96
1340-SW	15,700	7,590	23.40	2-5″ 1-4″	2-5″	24 x 24	65	102
1440-SW	17,000	8,250	25.34	2-5″ 1-4″	2-5″	24 x 24	65	108
1540-SW	18,300	8,910	27.29	2-5″ 1-4″	2-5″	24 x 28	65	115
1640-SW	19,600	9,570	29.23	2-5″ 2-4″	2-5″	28 x 28	70	121
1740-SW	20,900	10,230	31.17	2-5″ 2-4″	2-5″	28 x 28	70	128
1840-SW	22,200	10,890	33.12	2-5″ 2-4″	2-5″	28 x 32	70	135

† Square feet of exterior boiler surface.

Approximately 57 pounds of insulation per section required to provide boiler covering 1½ inches thick.

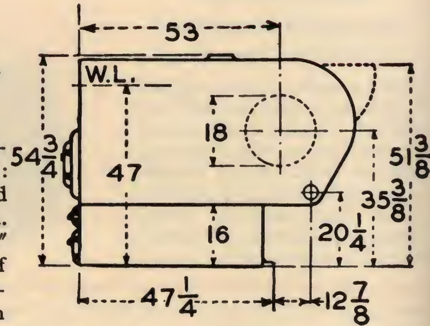
Supply Outlet Tappings: One 5″ outlet in right end section and one 5″ outlet in left end section. Additional 4″ outlets are furnished in intermediate sections in boilers having 12 or more sections. See dimension table, page 147, for location of intermediate sections with outlets.

Return Inlet Tappings: One 5″ inlet in right end section and one 5″ inlet in left end section. Intermediate sections are not furnished with inlets, but additional inlet-tappings can be furnished on end sections when ordered shipped from point of manufacture.

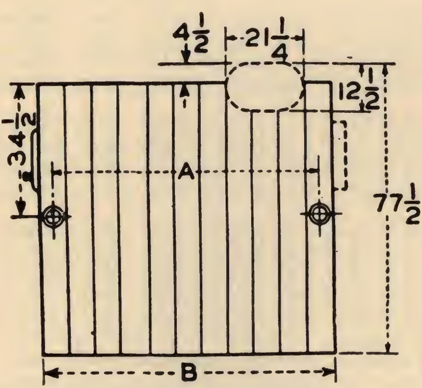
Series No. 40—

Steam and Water Dimensions

Indirect External Water Heater Tappings: One 2″ tapping located on side of left end section. Boss for additional 2″ tapping located on side of right end section. Additional 1½″ tappings can be furnished on front of intermediate sections.



End view, showing dimensions.



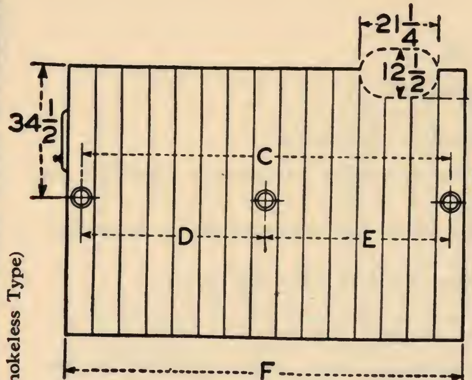
Top view, 6 to 11 section boiler.

Boiler Number	A	B
640	35½″	42″
740	42½″	49″
840	49½″	56″
940	56½″	63″
1040	63½″	70″
1140	70½″	77″

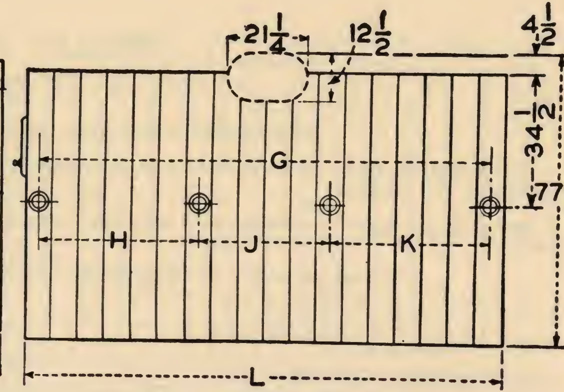
Smoke Outlet:—End outlet furnished on boilers up to 10 sections. Rear Outlet furnished on boilers having 11 or more sections. See page 140.

Dimensions of boilers having 12 or more sections are shown on page 147.

Standard assembly of sections is shown on page 149.



Top view, 12 to 15 section boiler.



Top view, 16 to 18 section boiler.

Series No. 40—Steam and Water Dimensions

Boiler Number	C	D	E	F
1240	77½″	35¼″	42¼″	84″
1340	84½″	42¼″	42¼″	91″
1440	91½″	42¼″	49¼″	98″
1540	98½″	49¼″	49¼″	105″

Boiler Number	G	H	J	K	L
1640	105½″	35¼″	35″	35¼″	112″
1740	112½″	35¼″	42″	35¼″	119″
1840	119½″	42¼″	35″	42¼″	126″

Dimensions subject to slight variations in assembly.
Ashpit and foundation measurements are shown on page 150.

Series No. 30

Hard Coal and Smokeless

Standard Assembly of Boiler Sections

The series No. 30 in either hard coal or smokeless types, can easily be correctly assembled by following this diagram:

LE°—Left end, supply outlet and return inlet; RE°—Right end, supply outlet and return inlet; I—Intermediate plain; W—Full smoke outlet on back, plain.

Arrangement of Sections—Steam and Water Boilers

12	11	10	9	8	7	6	5	4	3	2	1	Boiler Numbers		Grates		Water Fronts				
												Regular	Smokeless	Plain	Shaking	No. 4	No 5	No. 6	No. 7	No. 8
							LE°	I	I	I	RE°	35	530	2	2		1			
						LE°	I	I	I	I	RE°	36	630	3	2			1		
					LE°	I	I	I	I	I	RE°	37	730	4	2				1	
				LE°	I	I	I	I	I	I	RE°	38	830	5	2					1
			LE°	I	I	I	I	I	I	I	RE°	39	930	5	3	1	1			
		LE°	I	I	I	I	I	I	I	I	RE°	310	1030	5	4		2			
	LE°	I	I	I	I	I	I	I	W	W	RE°	311	1130	7	3	1			1	
LE°	I	I	I	I	I	I	I	I	W	W	RE°	312	1230	7	4			2		

(°) after key letter indicates section has supply outlet tapping.

Center to center distance between sections is 7 inches.

Series No. 40

Hard Coal and Smokeless

Standard Assembly of Boiler Sections

The Series No. 40 in either hard coal or smokeless types, can easily be correctly assembled by following this diagram:

LE°—Left end, supply outlet and return inlet; RE°—Right end, supply outlet and return inlet; I—Intermediate plain; T°—Intermediate supply outlet, no return; U—Half smoke outlet on back, plain; W—Full smoke outlet on back, plain.

Arrangement of Sections—Steam and Water Boilers

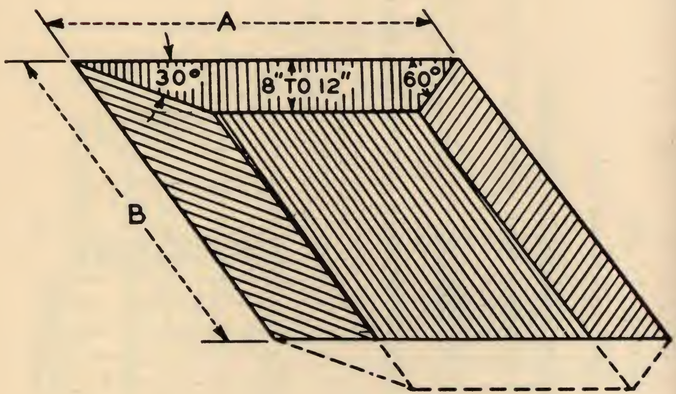
																		Boiler Numbers		Grates		Water Fronts					
18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	Regular	Smoke-less	Plain	Shak-ing	No. 4	No. 5	No. 6	No. 7	No. 8	No. 9
												LE°	I	I	I	I	RE°	46	640	3	2			1			
											LE°	I	I	I	I	I	RE°	47	740	4	2				1		
										LE°	I	I	I	I	I	I	RE°	48	840	5	2					1	
									LE°	I	I	I	I	I	I	I	RE°	49	940	5	3	1	1				
								LE°	I	I	I	I	I	I	I	I	RE°	410	1040	5	4		2				
							LE°	I	I	I	I	I	I	W	W	W	RE°	411	1140	7	3	1			1		
						LE°	I	I	I	I	T°	I	I	W	W	W	RE°	412	1240	7	4			2			
					LE°	I	I	I	I	I	T°	I	U	W	W	W	RE°	413	1340	8	4			1	1		
				LE°	I	I	I	I	I	T°	I	I	U	W	W	W	RE°	414	1440	9	4				2		
			LE°	I	I	I	I	I	I	T°	I	I	U	W	W	W	RE°	415	1540	10	4				1	1	
		LE°	I	I	I	I	T°	H	W	W	W	T°	I	I	I	I	RE°	416	1640	11	4					2	
	LE°	I	I	I	I	T°	H	W	W	W	I	T°	I	I	I	I	RE°	417	1740	11	5					1	1
LE°	I	I	I	I	I	T°	H	W	W	W	T°	I	I	I	I	I	RE°	418	1840	11	6						2

(°) after key letter indicates section has supply outlet tapping.

Center to center distance between tappings is 7 inches.

Foundation and Pitting Dimensions

Series No. 30 and 40



The tables on the opposite page give all the measurements necessary for the proper pitting of all types of National Low Water Line Boilers; Series No. 30, and Series No. 40, Hard Coal and Smokeless Types. Wherever conditions will permit, an ash pit is recommended. Measurements refer to corresponding letters on the diagram. When basement floor is not yet laid, surround pit with a foundation 10 to 12 inches wide.

Series No. 30 and No. 40
Foundation and Pitting Dimensions

Series No. 30

Boiler Numbers		A	B
Hard Coal	Smokeless		
35	530	30″	29″
36	630	30″	36″
37	730	30″	43″
38	830	30″	50″
39	930	30″	57″
310	1030	30″	64″
311	1130	30″	71″
312	1230	30″	78″

Series No. 40

Boiler Numbers		A	B
Hard Coal	Smokeless		
46	640	40″	36″
47	740	40″	43″
48	840	40″	50″
49	940	40″	57″
410	1040	40″	64″
411	1140	40″	71″
412	1240	40″	78″
413	1340	40″	85″
414	1440	40″	92″
415	1540	40″	99″
416	1640	40″	106″
417	1740	40″	113″
418	1840	40″	120″

National Gothic Hot Water Supply Boiler

ALL year round National Hot Water Supply Boilers furnish a constant and unfailing supply of steaming hot water, at small cost, and with little attention. The line provides sizes suitable for applications ranging from small to large homes, and small apartments, with requirements of from 64 to 198 gallons per hour.

Base bottom and legs regularly furnished with No. 10 Gothic, and on special order can be furnished with Numbers 12, 14, and 16 Gothic.

Economy . . .

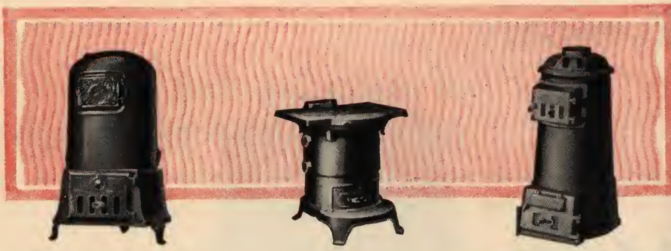
of operation that comes from proper design

MODERN standards of living demand hot water the year round. The best, most economical method of supplying it is the utilization of National Hot Water Supply Boilers.

Both winter and summer requirements are satisfied. The generous proportions of the fire pot makes frequent attention unnecessary. The fire pot is entirely surrounded with a jacket of water, which absorbs a large proportion of the heat units in the fuel. The relatively low temperature of this water keeps radiation down so that the temperature of the basement is little affected, in the summer. National Hot Water Supply Boilers are constructed to stand the unusual pressure strains to which this type of service subjects them.

Hot Water Supply Boilers, where practicable, are recommended in preference to installing coils in the fire box of house heating boilers. Such coils absorb heat that may be needed for warming the home; they cool the gases in the fire box, thus interfering with proper combustion and often form a nucleus for clinker, which reduces the efficiency of coil and boiler alike.

NATIONAL HOT WATER SUPPLY BOILERS



No. 10, 12, 14 and 16 Gothic — *No. 5 Laundry* — *No. 10-N Gothic*

National Gothic Hot Water Supply Boilers

Gallons of water each boiler will heat

Boiler Number	Nominal Diameter Grate Inches	* Tank Capacity Gallons per Hour	Outlets		Inlets		Diameter Smoke Collar Inches
			No.	Size Inches	No.	Size Inches	
National Gothic							
10	10	64	1	2	2	2	5⅛
10-N	10	78	1	1½	1	1½	5
12	12	111	1	2	2	2	6
14	14	165	1	2½	2	2	6
16	16	198	1	2½	2	2	7
National Laundry Heater (Gurney Design)							
5	12	85	1	1	1	1	6

*These capacities based on an 8-hour firing period and a 25 degree temperature rise.

No. 10 National Gothic

Hours	5	6	7	8	9	10	11	12
Power per Hour—B.T.U.	21,360	17,820	15,240	13,380	11,880	10,680	9,720	8,880
Temp. Rise per Hour	Capacity in Gallons per Hour							
25°	103	86	73	64	57	51	47	43
50°	51	43	36	32	28	26	24	22
100°	26	22	18	16	14	13	12	11

No. 10-N National Gothic

Hours	5	6	7	8	9	10	11	12
Power per Hour—B.T.U.	26,040	21,720	18,600	16,260	14,460	13,020	11,820	10,860
Temp. Rise per Hour	Capacity in Gallons per Hour							
25°	125	104	90	78	70	63	57	50
50°	63	52	45	39	35	32	29	25
100°	31	26	23	20	18	16	14	12

No. 12 National Gothic

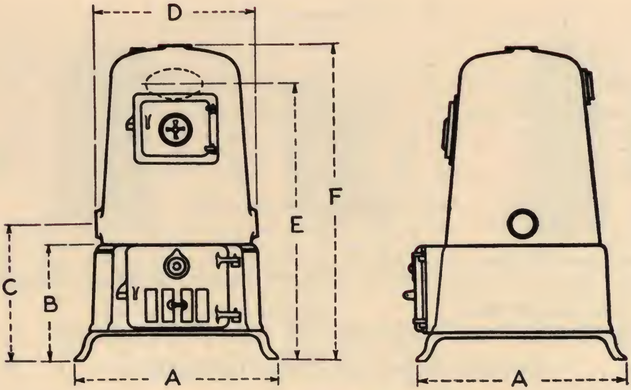
Hours	5	6	7	8	9	10	11	12
Power per Hour—B.T.U.	36,720	30,600	26,220	22,980	20,400	18,360	16,680	15,300
Temp. Rise per Hour	Capacity in Gallons per Hour							
25°	176	147	126	111	98	88	80	74
50°	88	74	63	55	49	44	40	37
100°	44	37	31	28	25	22	20	19

No. 14 National Gothic

Hours	5	6	7	8	9	10	11	12
Power per Hour—B.T.U.	54,840	45,720	39,180	34,260	30,480	27,420	24,900	22,860
Temp. Rise per Hour	Capacity in Gallons per Hour							
25°	264	220	188	165	146	132	120	110
50°	132	110	94	82	73	66	60	55
100°	66	55	47	41	37	33	30	28

No. 16 National Gothic

Hours	5	6	7	8	9	10	11	12
Power per Hour—B.T.U.	65,640	54,720	46,860	41,040	36,480	32,820	29,820	27,300
Temp. Rise per Hour	Capacity in Gallons per Hour							
25°	316	263	226	198	175	158	144	132
50°	158	132	113	99	87	79	72	66
100°	79	66	56	49	44	39	36	33



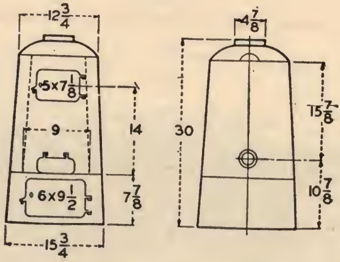
Gothic No. 10, 12, 14 and 16
Dimensions

Boiler Number	A	B	C	D	E	F
Gothic No. 10	18 "	13 "	14⅝"	14½"	28½"	33¾"
Gothic No. 12	21½"	13¾"	16 "	16½"	30⅝"	35⅝"
Gothic No. 14	24 "	14¾"	17⅜"	19½"	33⅛"	39⅛"
Gothic No. 16	25½"	15¾"	18½"	21⅜"	34¾"	40⅞"

National Gothic Hot Water Supply Boilers (No. 10, 12, 14 and 16) are of sturdy construction, capable and efficient. A roomy fire box holds a heavy fuel charge, requiring attention only infrequently. The range of sizes provides for hot water output requiring the heating of 64 to 198 gallons of water per hour.

Regularly tested to 80 pounds hydrostatic pressure for 30 pounds working pressure.

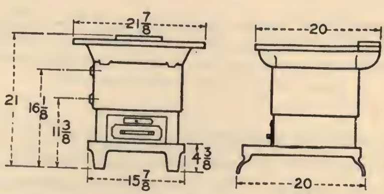
On special order these boilers are tested to 200 pounds hydrostatic pressure for a maximum working pressure of 80 pounds. These special high test boilers are shipped only from New Castle plant. A pressure relief valve should be installed on all jobs.



Diameter of smoke collar 5"

National Gothic No. 10-N

Has an unusually deep fire box, and for that reason requires only infrequent attention. Is of sufficient capacity to furnish hot water for homes with two or three baths.

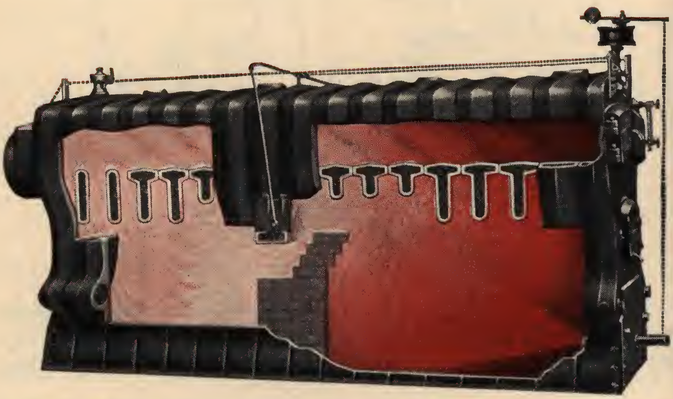


Diameter of smoke collar 6"

National Laundry No. 5

This laundry boiler has sufficient capacity to take care of the hot water requirements in the average home. A wash boiler may, if desired, be placed on the flat top.

Oil Burning . . .
With Efficiency, Economy, and Bonded Results



S-04017 National Bonded Super-Smokeless Oil Burning Boiler, showing typical illustration of the application of a "gun" type oil burner. The air baffle section and bridge-wall section may be omitted if the boiler is to be used exclusively for oil burning.

National Bonded Oil Burning Boilers have achieved remarkable success in burning oil. The scientific proportioning of combustion chambers, and the design of fire travels and waterways, were developed after years of careful research, testing and experiment. They combine to set up a balanced condition that ideally fits the boilers for economical operation with rotary, gun, and pot types of oil burners.

Scientifically designed, the heating qualities of National Bonded Oil Burning Boilers are not a matter of speculation. Satisfactory heating qualities are assured.

National Round Boilers—Oil Burning Type

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam			Specifications Applying to Both			Water		
Steam Boiler No.	Bonded Direct C. I. Radiation Sq. Ft.	Height Supply Outlets Inches	Outlets Number and Size Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler No.	Bonded Direct C. I. Radiation Sq. Ft.	Height Supply Outlet Inches
017-5S	195	51	2-2½″	8 x 8	30	017-5W	320	46¾
017-6S	215	55½	2-2½″	8 x 8	35	017-6W	355	51⅛
020-5S	300	56½	2-2½″	8 x 8	35	020-5W	495	51¾
020-6S	325	61½	2-2½″	8 x 12	35	020-6W	535	56¾
023-5S	410	56½	2-3″	8 x 12	35	023-5W	675	50⅜
023-6S	445	61½	2-3″	8 x 12	40	023-6W	730	55⅜
026-5S	525	56½	2-3″	8 x 12	35	026-5W	865	50¾
026-6S	575	61½	2-3″	8 x 12	40	026-6W	945	55¾
029-5S	675	57½	2-4″	12 x 12	35	029-5W	1,115	51¾
029-6S	725	62½	2-4″	12 x 12	40	029-6W	1,195	56¾
032-5S	850	57½	2-4″	12 x 12	40	032-5W	1,400	51¾
032-6S	925	62½	2-4″	12 x 12	40	032-6W	1,530	56¾

Series Number	Height of Base	Width of Base	Height to Center Return Inlet	Distance Normal Grate to Crown	Ashpit Door Dimensions	Fire Door Dimensions
17	12″	22″	14¼″	22½″	9⅛″ x 13″	9″ x 10¾″
20	12″	28½″	14½″	24″	9″ x 13″	9″ x 11″
23	12¼″	31⅜″	14½″	24½″	9″ x 13″	8⅞″ x 13″
26	12¼″	34½″	15″	24½″	9″ x 15″	9″ x 13″
29	12¼″	37½″	15½″	26¼″	9″ x 15″	9⅞″ x 15″
32	12½″	40⅜″	15½″	26¼″	9″ x 15″	10″ x 15″

One 1½″ tapping in dome section for indirect heater.
Additional dimensions are shown on pages 49 and 51.

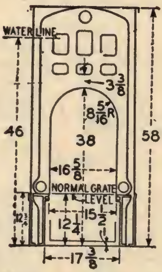
Jacketed Square Boilers—Oil Burning Type

Series No. 2, 3 and 4

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
02-S-5	350	2–2½″	16½	8 x 8	30	02-W-5	580
02-S-6	460	2–2½″	20¾	8 x 8	30	02-W-6	760
02-S-7	570	2–2½″	25	8 x 12	35	02-W-7	940
02-S-8	680	3–2½″	29¼	8 x 12	35	02-W-8	1,120
02-S-9	790	3–2½″	33½	8 x 12	35	02-W-9	1,300
03-S-5	580	2–3″	23⅛	8 x 12	35	03-W-5	950
03-S-6	730	2–3″	29	8 x 12	35	03-W-6	1,200
03-S-7	880	3–3″	34⅞	8 x 12	35	03-W-7	1,450
03-S-8	1,030	3–3″	40¾	8 x 12	40	03-W-8	1,700
04-S-5	840	2–4″	28⅛	12 x 12	30	04-W-5	1,380
04-S-6	1,050	2–4″	35	12 x 12	35	04-W-6	1,730
04-S-7	1,260	3–4″	42⅞	12 x 12	35	04-W-7	2,080
04-S-8	1,470	3–4″	49¾	12 x 12	40	04-W-8	2,430
04-S-9	1,680	3–4″	56⅝	12 x 16	45	04-W-9	2,780

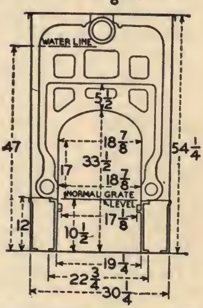
Jacketed Square Boilers—Oil Burning Type



Series No. 2—Dimensions

Fire Door 9″ x 13¼″
Ashpit Door 8″ x 11½″

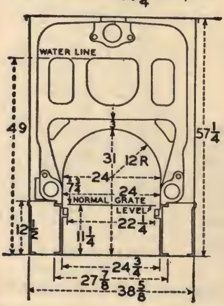
One 1½″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on right or left side of intermediate sections on special order. See pages 20 and 21 for additional dimensions and arrangement of sections.



Series No. 3—Dimensions

Fire Door 8⅜″ x 13″
Ashpit Door 8⅜″ x 13″

One 2″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on right or left side of intermediate sections on special order. See page 25 for additional dimensions and arrangement of sections.



Series No. 4—Dimensions

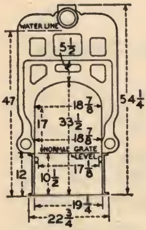
Fire Door 10″ x 16″
Ashpit Door 9½″ x 13″

One 2″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on right or left side of intermediate sections on special order. See page 31 for additional dimensions and arrangement of sections.

Novus Sectional Boilers—Oil Burning Type

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
Series No. 20							
020-5-S	580	2-3″	23⅛	8 x 12	35	05-20-W	950
020-6-S	730	2-3″	29	8 x 12	35	06-20-W	1,200
020-7-S	880	3-3″	34⅞	8 x 12	35	07-20-W	1,450
020-8-S	1,030	3-3″	40¾	8 x 12	40	08-20-W	1,700
020-9-S	1,180	3-3″	46⅝	8 x 12	40	09-20-W	1,950
020-10-S	1,330	3-3″	52½	8 x 12	40	010-20-W	2,200
Series No. 25							
025-5-S	840	2-4″	28⅛	12 x 12	30	05-25-W	1,380
025-6-S	1,050	2-4″	35	12 x 12	35	06-25-W	1,730
025-7-S	1,260	3-4″	41⅞	12 x 12	35	07-25-W	2,080
025-8-S	1,470	3-4″	48¾	12 x 12	40	08-25-W	2,430
025-9-S	1,680	3-4″	55⅝	12 x 16	45	09-25-W	2,780
025-10-S	1,890	3-4″	62½	12 x 16	45	010-25-W	3,130
025-11-S	2,100	3-4″	69⅜	12 x 16	45	011-25-W	3,480
025-12-S	2,310	3-4″	76¼	12 x 16	50	012-25-W	3,830

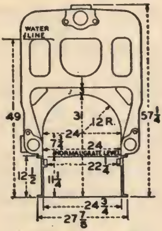


Series No. 20

Dimensions

Series No. 20	Series No. 25
Fire Door	
8⅜″ x 13″	10″ x 16″
Ashpit Door	
8⅜″ x 13″	9½″ x 13″

One 2″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on side of intermediate sections on special order.



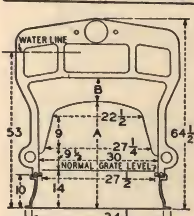
Series No. 25

See pages 63 and 67 for additional dimensions and arrangement of sections.

Imperial Sectional Boilers—Oil Burning Type

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
Series No. 32							
S-0532	1,400	2-5″	32½	14 x 14	40	W-0532	2,315
S-0632	1,750	2-5″	40¾	15 x 15	40	W-0632	2,895
S-0732	2,100	2-5″	49	16 x 16	40	W-0732	3,475
S-0832	2,450	2-5″	57¼	16 x 16	50	W-0832	4,055
S-0932	2,800	3-5″	65½	18 x 18	50	W-0932	4,635
Series No. 42							
S-0642	2,500	2-5″	40¾	16 x 16	50	W-0642	4,100
S-0742	3,100	2-5″	49	18 x 18	50	W-0742	5,100
S-0842	3,700	3-5″	57¼	18 x 18	55	W-0842	6,100
S-0942	4,300	3-5″	65½	20 x 20	55	W-0942	7,100
S-01042	4,900	3-5″	73¾	20 x 20	60	W-01042	8,100
S-01142	5,500	3-5″	82	21 x 21	60	W-01142	9,100
S-01242	6,000	4-5″	73¾	22 x 22	65	W-01242	9,900
S-01342	6,500	4-5″	82	22 x 22	70	W-01342	10,700
S-01442	7,000	4-5″	82	23 x 23	75	W-01442	11,500
S-01542	7,500	4-5″	82	23 x 23	75	W-01542	12,300
S-01642	8,000	4-5″	90¼	24 x 24	80	W-01642	13,100

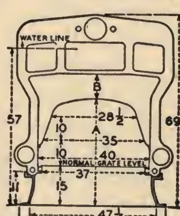


Series No. 32

Dimensions

Series No. 32		Series No. 42	
Fire Door			
9½″ x 17″		12″ x 23″	
Ash Pit Door			
8¾″ x 18¾″		10½″ x 23¾″	
A	B	A	B
Low Crown Section			
35¼″	8¼″	38¼″	9″
High Crown Section			
42½″	1″	46¼″	1″

2″ tapping on rear section for indirect water heater. Additional 1½″ tappings can be furnished on intermediate sections.



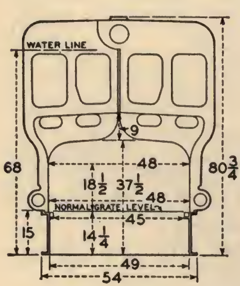
Series No. 42

See pages 74 to 79 for additional dimensions and arrangement of sections.

Novus Sectional Boilers—Oil Burning Type
Series No. 48

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
048-6-S	4,100	2-6″	50¾	20 x 20	60	06-48-W	6,700
048-7-S	5,000	2-6″	61¼	20 x 24	65	07-48-W	8,300
048-8-S	5,800	3-6″	71¾	24 x 24	70	08-48-W	9,600
048-9-S	6,600	3-6″	82¼	24 x 28	75	09-48-W	10,900
048-10-S	7,400	3-6″	92¾	24 x 28	75	010-48-W	12,200
048-11-S	8,200	4-6″	103¼	28 x 28	80	011-48-W	13,500
048-12-S	9,000	4-6″	113¾	28 x 28	80	012-48-W	14,800
048-13-S	9,800	5-6″	124¼	28 x 28	80	013-48-W	16,100
048-14-S	10,600	5-6″	134¾	28 x 32	90	014-48-W	17,400
048-15-S	11,400	5-6″	145¼	28 x 32	90	015-48-W	18,700



Dimensions

2 Fire Doors 10¾″ x 17¾″

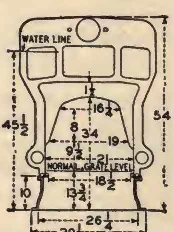
Ashpit Door 11″ x 19¾″

One 2″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on side of intermediate sections on special order. See pages 85 and 86 for additional dimensions and arrangement of sections.

Super-Smokeless Boilers—Oil Burning Type

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
Series No. 24							
S-0245	900	1-4″	32½	12 x 12	40	W-0245	1,480
S-0246	1,200	2-4″	40¾	13 x 13	40	W-0246	1,980
S-0247	1,500	2-4″	49	13 x 13	45	W-0247	2,480
S-0248	1,800	2-4″	57¼	14 x 14	50	W-0248	2,980
S-0249	2,100	3-4″	65½	14 x 14	55	W-0249	3,480
Series No. 33							
S-0335	1,550	1-5″	32½	14 x 14	40	W-0335	2,575
S-0336	1,975	2-5″	40¾	15 x 15	40	W-0336	3,275
S-0337	2,400	2-5″	49	16 x 16	40	W-0337	3,975
S-0338	2,825	2-5″	57¼	16 x 16	50	W-0338	4,675
S-0339	3,250	3-5″	65½	18 x 18	50	W-0339	5,375
S-03310	3,675	3-5″	73¾	18 x 18	55	W-03310	6,075
S-03311	4,100	3-5″	82	18 x 18	60	W-03311	6,775
S-03312	4,525	3-5″	90¼	18 x 18	60	W-03312	7,475



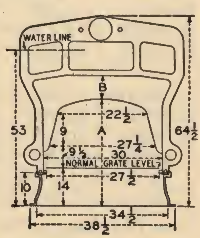
Series No. 24

Dimensions

	Series No. 24	Series No. 33
Fire Door	9¼″ x 16″	9½″ x 17″
Ashpit Door	8¾″ x 19″	8¾″ x 18¾″

	A	B
Low Crown Section	35¼″	8¼″
High Crown Section	42½″	1″

One 2″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on side of intermediate sections on special order.



Series No. 33

See pages 98 - 99 and 100 - 101 for additional dimensions and arrangement of sections.

Super-Smokeless Boilers—Oil Burning Type
Series No. 40

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

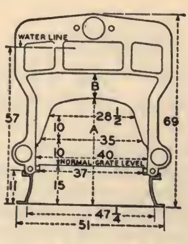
Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
S-0406	2,600	2-5″	40¾	16 x 16	50	W-0406	4,200
S-0407	3,200	2-5″	49	18 x 18	50	W-0407	5,200
S-0408	3,800	3-5″	57¼	18 x 18	55	W-0408	6,200
S-0409	4,400	3-5″	65½	20 x 20	55	W-0409	7,200
S-04010	5,000	3-5″	73¾	20 x 20	60	W-04010	8,200
S-04011	5,600	3-5″	82	21 x 21	60	W-04011	9,200
S-04012	6,200	4-5″	73¾	22 x 22	65	W-04012	10,200
S-04013	6,800	4-5″	73¾	22 x 22	70	W-04013	11,200
S-04014	7,400	4-5″	82	23 x 23	75	W-04014	12,200
S-04015	8,000	4-5″	82	23 x 23	75	W-04015	13,200
S-04016	8,600	4-5″	82	24 x 24	80	W-04016	14,200
S-04017	9,200	4-5″	82	24 x 24	80	W-04017	15,200
S-04018	9,800	4-5″	82	25 x 25	80	W-04018	16,200
S-04019	10,400	5-5″	82	25 x 25	85	W-04019	17,200
S-04020	11,000	5-5″	82	25 x 25	90	W-04020	18,200
S-04021	11,600	5-5″	82	25 x 25	100	W-04021	19,200
S-04022	12,200	5-5″	82	26 x 26	100	W-04022	20,200
S-04023	12,800	5-5″	82	27 x 27	100	W-04023	21,200
S-04024	13,400	5-5″	82	27 x 27	100	W-04024	22,200

Fire box length given above is distance from front of boiler to the bridgewall section. Add 8¼″ per section to dimensions given above to obtain distance from front section to back section.

Super-Smokeless Boilers—Oil Burning Type
Duplex Series No. 82

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size Inches	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
S-0827	7,400	6-5″	49	23 x 23	60	W-0827	12,000
S-0828	8,600	6-5″	57¼	24 x 24	65	W-0828	14,000
S-0829	9,800	6-5″	65½	25 x 25	65	W-0829	16,000
S-08210	11,000	6-5″	73¾	26 x 26	70	W-08210	18,000
S-08211	12,200	6-5″	82	27 x 27	70	W-08211	20,000
S-08212	13,400	8-5″	73¾	28 x 28	75	W-08212	22,000
S-08213	14,600	8-5″	73¾	29 x 29	80	W-08213	24,000
S-08214	15,800	8-5″	82	29 x 29	85	W-08214	26,000
S-08215	17,000	8-5″	82	30 x 30	85	W-08215	28,000
S-08216	18,200	8-5″	82	31 x 31	90	W-08216	30,000
S-08217	19,400	8-5″	82	32 x 32	90	W-08217	32,000
S-08218	20,600	8-5″	82	32 x 32	90	W-08218	34,000



Series No. 40

	A	B
Low Crown Section	38¼″	9″
High Crown Section	46¼″	1″

Dimensions
Series No. 40 and No. 82

Fire Door Opening	12″ x 23″
Ashpit Door Opening	10½″ x 23¾″

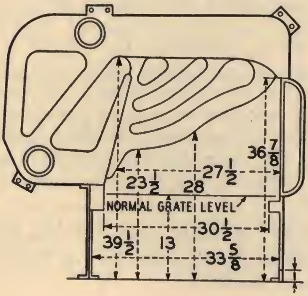
One 2″ tapping on rear of back section for indirect water heater. Additional 1½″ tappings are furnished on side of intermediate sections on special order.

See pages 110-113 and 118-121 for additional dimensions and arrangements of sections.

Low Water Line Boilers—Oil Burning Type

The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size In.	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
035-S	1,000	2-4″	28½	12 x 12	40	035-W	1,650
036-S	1,300	2-4″	35½	12 x 12	40	036-W	2,150
037-S	1,600	2-4″	42½	12 x 12	40	037-W	2,650
038-S	1,900	2-4″	49½	12 x 12	40	038-W	3,150
039-S	2,200	2-4″	56½	12 x 16	45	039-W	3,650
0310-S	2,500	2-4″	63½	12 x 16	45	0310-W	4,150
0311-S	2,800	2-4″	70½	12 x 16	50	0311-W	4,650
0312-S	3,100	2-4″	77½	16 x 16	50	0312-W	5,150



Dimensions

Fire Door	9½″ x 14½″
Ashpit Door	9½″ x 14½″

One 2″ tapping on side of left end section for indirect water heater. Additional 1½″ tappings are furnished on the front of intermediate sections on special order.

See pages 129, 148 for additional dimensions and arrangement of sections.

Low Water Line Boilers—Oil Burning Type

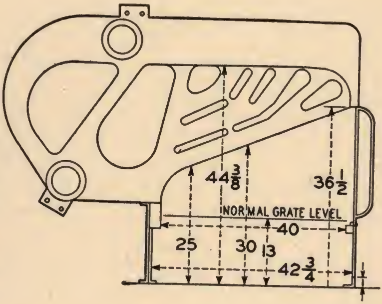
The number of square feet of direct cast iron radiation each boiler is bonded to heat is listed under the heading, "Bonded Direct C. I. Radiation, Square Feet."

Steam		Specifications Applying to Both				Water	
Steam Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.	Outlets Number and Size In.	Fire Box Length Inches	Chimney Area Inches	Chimney Height Feet	Water Boiler Number	Bonded Direct C. I. Radiation Sq. Ft.
046-S	2,000	2-5″	35½	12 x 16	45	046-W	3,300
047-S	2,500	2-5″	42½	12 x 16	45	047-W	4,100
048-S	3,000	2-5″	49½	16 x 16	50	048-W	4,900
049-S	3,500	2-5″	56½	16 x 20	55	049-W	5,700
0410-S	4,000	2-5″	63½	16 x 20	55	0410-W	6,500
0411-S	4,500	2-5″	70½	20 x 20	55	0411-W	7,300
0412-S	5,000	2-5″ 1-4″	77½	20 x 20	60	0412-W	8,100
0413-S	5,500	2-5″ 1-4″	84½	24 x 24	65	0413-W	8,900
0414-S	6,000	2-5″ 1-4″	91½	24 x 24	65	0414-W	9,700
0415-S	6,500	2-5″ 1-4″	98½	24 x 28	65	0415-W	10,500
0416-S	7,000	2-5″ 2-4″	105½	28 x 28	70	0416-W	11,300
0417-S	7,500	2-5″ 2-4″	112½	28 x 28	70	0417-W	12,100
0418-S	8,000	2-5″ 2-4″	119½	28 x 32	70	0418-W	12,900

Dimensions
Fire Door 9½″ x 14½″
Ashpit Door 9½″ x 14½″

One 2″ tapping on side of left end section for indirect water heater. Additional 1½″ tappings are furnished on the front of intermediate sections on special order.

See pages 138 and 149 for additional dimensions and arrangement of sections.



NATIONAL AERO RADIATION

NATIONAL AERO RADIATION

At once attractive and efficient, National Aero Radiation is noteworthy for the *fullness* of line that comes with a complete variety of shapes and sizes, as well as for the *broadness* of line that comes through a design which adapts itself to every conceivable application, giving constant evidence of its utility and effectiveness.

Efficiency . . .

Found in a Quest For Beauty

ODDLY enough, the design that gives National Radiation its outstanding attractiveness contributes most to its efficiency. The slender tubes and wide spacing gives the proper ratio of heating surface to air space, and increases the heat emission an amazing amount.

The radiators were designed not only to increase the output of warmth by convection, but also the radiant heat. Radiant heat rays, tests indicate, move at right angles to the face from which they emanate. By the combination of a concave surface, and proper spacing, these beams of heat have free exit in National Radiators.

National also used an octagonal, instead of the usual rounded barrel. For the same water or steam area, there is a greater radiating surface—which is, of course, the result to be desired. In the total surface of an entire radiator the increase in radiating area is considerable, and contributes to the high efficiency which is Aero's prime characteristic.

Worth . . .

the effort, though harder to make

THE smooth surface of National Radiator sections, with its freedom from pits, depressions, and flaws, is only one result of a care in manufacturing that extends to every operation, no matter how small.

Each batch of metal is tested with scrupulous care, and the exact proportions of chemicals needed to attain the desired strength and resilience are added. The Seacoal process used in casting assures a fine surface—an essential if the radiators are to be painted, as is the trend today.

Each individual radiator section is subjected to a hydrostatic test in excess of 90 pounds. The section is rigidly inspected while under pressure and only those that are absolutely water tight and up to the high National standard are approved. All four nipple ports are reamed out at one operation on a special machine, thus assuring perfect alignment. After the sections are assembled into radiators, each radiator is again put under pressure and again rigidly inspected.

National Aero Malleable Push Nipple

Push Nipples . . .

speedily assembled, protection assured

THE malleable push nipple type of construction gives a permanently tight metal-to-metal joint, not dependent on gaskets to protect against leaks. It is significant that in boilers, where strains due to expansion and contraction are greatest, and where leaks must be guarded against at all cost, *push nipples are used exclusively* by leading boiler manufacturers. No stronger evidence of their value could be presented.

The malleable iron push nipples are not machined, but finished by a special process, which leaves intact a tough outer skin in which most of the strength resides. Originally, steel push nipples were used by the industry generally, but rapid corrosion made them short lived and impractical. Unable to successfully finish cast iron nipples to accurate limits, some manufacturers turned to screw nipples as the only alternative. National, realizing that cutting threads on a malleable nipple destroyed the effectiveness of the tough outer skin, patiently experimented and was one of the first companies to successfully utilize the malleable iron push nipple.

This type of connection is now generally recognized as the best because it forms a permanently tight iron-to-iron joint, not dependent upon gaskets to make it water-tight.

NATIONAL AERO THREE TUBE RADIATION

Graceful and pleasing, this slender model is particularly adapted to narrow corridors, and rooms where space is at a premium.

Three Tube Sizes and Ratings

Number of Sections	*Length 2½ in. Per Sec.	Square Feet Per Section				
		36-in. Height 3½ Sq. Ft. Per Sec.	30-in. Height 3 Sq. Ft. Per Sec.	26-in. Height 2⅓ Sq. Ft. Per Sec.	23-in. Height 2 Sq. Ft. Per Sec.	20-in. Height 1¾ Sq. Ft. Per Sec.
2	5	7	6	4⅔	4	3½
3	7½	10½	9	7	6	5¼
4	10	14	12	9⅓	8	7
5	12½	17½	15	11⅔	10	8¾
6	15	21	18	14	12	10½
7	17½	24½	21	16⅓	14	12¼
8	20	28	24	18⅔	16	14
9	22½	31½	27	21	18	15¾
10	25	35	30	23⅓	20	17½
11	27½	38½	33	25⅔	22	19¼
12	30	42	36	28	24	21
13	32½	45½	39	30⅓	26	22¾
14	35	49	42	32⅔	28	24½
15	37½	52½	45	35	30	26¼
16	40	56	48	37⅓	32	28
17	42½	59½	51	39⅔	34	29¾
18	45	63	54	42	36	31½
19	47½	66½	57	44⅓	38	33¼
20	50	70	60	46⅔	40	35
21	52½	73½	63	49	42	36¾
22	55	77	66	51⅓	44	38½
23	57½	80½	69	53⅔	46	40¼
24	60	84	72	56	48	42
25	62½	87½	75	58⅓	50	43¾
Distance from floor to center of top tapping.		33 13/16	27 27/32	23 13/16	20 53/64	17 27/32
Distance from floor to center of bottom tapping.		4½	4½	4½	4½	4½

Detailed measurements are given on page 190.

*Add ½-inch to length for each bushing.

Width of feet, 5⅛ inches. Width of section, 5⅛ inches.

Tapped 1½ inches top and bottom both ends and bushed to sizes required.

National Aero Radiators are furnished legless or with legs 6 inches from floor to center of tapping boss when ordered.

To determine the overall height of 3-tube legless radiators, deduct 2⅛ inches from the standard heights shown for this type. See pages 186, 190 for legless data.

Assembled with extra heavy malleable iron push nipples, top and bottom.

The slender tubes which contribute to the Aero Radiator's charm are responsible for its efficiency; they provide the scientifically correct ratio of air space to heating area

Four Tube Sizes and Ratings

Number of Sections	*Length 2½ in. Per Sec.	Square Feet Per Section 36-in. Height 4¼ Sq. Ft. Per Sec.	30-in. Height 3½ Sq. Ft. Per Sec.	26-in. Height 2¾ Sq. Ft. Per Sec.	23-in. Height 2½ Sq. Ft. Per Section	20-in. Height 2¼ Sq. Ft. Per Sec.
2	5	8½	7	5½	5	4½
3	7½	12¾	10½	8¼	7½	6¾
4	10	17	14	11	10	9
5	12½	21¼	17½	13¾	12½	11¼
6	15	25½	21	16½	15	13½
7	17½	29¾	24½	19¼	17½	15¾
8	20	34	28	22	20	18
9	22½	38¼	31½	24¾	22½	20¼
10	25	42½	35	27½	25	22½
11	27½	46¾	38½	30¼	27½	24¾
12	30	51	42	33	30	27
13	32½	55¼	45½	35¾	32½	29¼
14	35	59½	49	38½	35	31½
15	37½	63¾	52½	41¼	37½	33¾
16	40	68	56	44	40	36
17	42½	72¼	59½	46¾	42½	38¼
18	45	76½	63	49½	45	40½
19	47½	80¾	66½	52¼	47½	42¾
20	50	85	70	55	50	45
21	52½	89¼	73½	57¾	52½	47¼
22	55	93½	77	60½	55	49½
23	57½	97¾	80½	63¼	57½	51¾
24	60	102	84	66	60	54
25	62½	106¼	87½	68¾	62½	56¼
Distance from floor to center of top tapping.		33 13/16	27 27/32	23 13/16	20 53/64	17 27/32
Distance from floor to center of bottom tapping.		4½	4½	4½	4½	4½

Detailed measurements are given on page 190.

*Add ½-inch to length for each bushing.

Width of feet, 6 13/16 inches. Width of section, 6 13/16 inches.

Tapped 1½ inches top and bottom both ends and bushed to sizes required.

National Aero Radiators are furnished legless or with legs 6 inches from floor to center of tapping boss when ordered.

To determine the overall height of 4-tube legless radiators deduct 2⅛ inches from the standard heights shown for this type. See pages 186, 190 for legless data.

Assembled with extra heavy malleable iron push nipples, top and bottom.

NATIONAL AERO FIVE TUBE RADIATION

This model finds its field in all general applications: homes, schools and everywhere.

Five Tube Sizes and Ratings

Number of Sections	*Length 2½ in. Per Sec.	Square Feet Per Section 36-in. Height 5 Sq. Ft. Per Sec.	30-in. Height 4⅓ Sq. Ft. Per Sec.	26-in. Height 3½ Sq. Ft. Per Sec.	23-in. Height 3 Sq. Ft. Per Sec.	20-in. Height 2⅔ Sq. Ft. Per Sec.
2	5	10	8⅔	7	6	5⅓
3	7½	15	13	10½	9	8
4	10	20	17⅓	14	12	10⅔
5	12½	25	21⅔	17½	15	13⅓
6	15	30	26	21	18	16
7	17½	35	30⅓	24½	21	18⅔
8	20	40	34⅔	28	24	21⅓
9	22½	45	39	31½	27	24
10	25	50	43⅓	35	30	26⅔
11	27½	55	47⅔	38½	33	29⅓
12	30	60	52	42	36	32
13	32½	65	56⅓	45½	39	34⅔
14	35	70	60⅔	49	42	37⅓
15	37½	75	65	52½	45	40
16	40	80	69⅓	56	48	42⅔
17	42½	85	73⅔	59½	51	45⅓
18	45	90	78	63	54	48
19	47½	95	82⅓	66½	57	50⅔
20	50	100	86⅔	70	60	53⅓
21	52½	105	91	73½	63	56
22	55	110	95⅓	77	66	58⅔
23	57½	115	99⅔	80½	69	61⅓
24	60	120	104	84	72	64
25	62½	125	108⅓	87½	75	66⅔
Distance from floor to center of top tapping.		33 13/16	27 27/32	23 13/16	20 53/64	17 27/32
Distance from floor to center of bottom tapping.		4½	4½	4½	4½	4½

Detailed measurements are given on page 190.

*Add ½-inch to length for each bushing.

Width of feet, 8 13/32 inches. Width of sections, 8 13/32 inches.

Tapped 1½ inches top and bottom both ends and bushed to sizes required.

National Aero Radiators are furnished legless or with legs 6 inches from floor to center of tapping boss when ordered.

To determine the overall height of 5 tube legless radiators deduct 2⅛ inches from the standard heights shown for this type. See pages 186, 190 for legless data.

Assembled with extra heavy malleable iron push nipples, top and bottom.

The six tube type provides an unusual amount of radiating surface, but being only nine inches wide takes up very little space

Six Tube Sizes and Ratings

Number of Sections	*Length 2½-in. Per Sec.	Square Feet Per Section				
		38-in. Height 6 Sq. Ft. Per Sec.	32-in. Height 5 Sq. Ft. Per Sec.	26-in. Height 4 Sq. Ft. Per Sec.	23-in. Height 3½ Sq. Ft. Per Sec.	20-in. Height 3 Sq. Ft. Per Sec.
2	5	12	10	8	7	6
3	7½	18	15	12	10½	9
4	10	24	20	16	14	12
5	12½	30	25	20	17½	15
6	15	36	30	24	21	18
7	17½	42	35	28	24½	21
8	20	48	40	32	28	24
9	22½	54	45	36	31½	27
10	25	60	50	40	35	30
11	27½	66	55	44	38½	33
12	30	72	60	48	42	36
13	32½	78	65	52	45½	39
14	35	84	70	56	49	42
15	37½	90	75	60	52½	45
16	40	96	80	64	56	48
17	42½	102	85	68	59½	51
18	45	108	90	72	63	54
19	47½	114	95	76	66½	57
20	50	120	100	80	70	60
21	52½	126	105	84	73½	63
22	55	132	110	88	77	66
23	57½	138	115	92	80½	69
24	60	144	120	96	84	72
25	62½	150	125	100	87½	75
Distance from floor to center of top tapping.		35⅞	29⅞	23⅞	20⅝	17⅞
Distance from floor to center of bottom tapping.		4½	4½	4½	4½	4½

Detailed measurements are given on page 190.

*Add ½ inch to length for each bushing.

Width of feet, 9 inches. Width of section, 9 inches.

Tapped 1½ inches top and bottom both ends and bushed to size required.

National Aero Radiators are furnished legless or with legs 6 inches from floor to center of tapping boss when ordered.

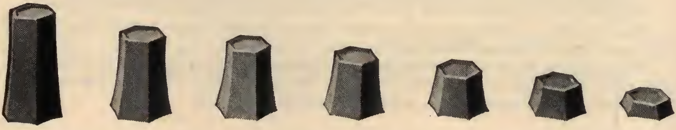
To determine the overall height of 6-tube legless radiators deduct 2½ inches from the standard heights shown for this type. See pages 186, 190 for legless data.

Assembled with extra heavy malleable iron push nipples.

A unit with tremendous warming capacity. The low heights fit nicely under windows, applying the heat where needed. The 36, 30 and 26 inch heights are used where space limitations will not permit a long radiator.

National Aero Radiator Pedestals

Where additional clearance beneath any Aero Radiator is desired cast iron Aero Radiator Pedestals should be used. Heights available are ½″, 1″, 1½″, 2″, 2½″, 3″, and 4″.



NATIONAL AERO SEVEN TUBE RADIATION

Seven Tube Sizes and Ratings

Number of Sections	*Length 2½-in. Per Sec.	Square Feet Per Section					
		36-in. Height 6¾ Sq. Ft. Per Sec.	30-in. Height 5½ Sq. Ft. Per Sec.	26-in. Height 4¾ Sq. Ft. Per Sec.	20-in. Height 3⅔ Sq.Ft. Per Sec.	16½-in. Height 3Sq. Ft. Per Sec.	13½-in. Height 2½Sq.Ft. Per Sec.
2	5	13½	11	9½	7⅓	6	5
3	7½	20¼	16½	14¼	11	9	7½
4	10	27	22	19	14⅔	12	10
5	12½	33¾	27½	23¾	18⅓	15	12½
6	15	40½	33	28½	22	18	15
7	17½	47¼	38½	33¼	25⅔	21	17½
8	20	54	44	38	29⅓	24	20
9	22½	60¾	49½	42¾	33	27	22½
10	25	67½	55	47½	36⅔	30	25
11	27½	74¼	60½	52¼	40⅓	33	27½
12	30	81	66	57	44	36	30
13	32½	87¾	71½	61¾	47⅔	39	32½
14	35	94½	77	66½	51⅓	42	35
15	37½	101¼	82½	71¼	55	45	37½
16	40	108	88	76	58⅔	48	40
17	42½	114¾	93½	80¾	62⅓	51	42½
18	45	121½	99	85½	66	54	45
19	47½	128¼	104½	90¼	69⅔	57	47½
20	50	135	110	95	73⅓	60	50
21	52½	141¾	115½	99¾	77	63	52½
22	55	148½	121	104½	80⅔	66	55
23	57½	155¼	126½	109¼	84⅓	69	57½
24	60	162	132	114	88	72	60
25	62½	168¾	137½	118¾	91⅔	75	62½
Distance from floor to center of top tapping.		33 13/16	27 27/32	23 13/16	17 27/32	14 11/32	11⅜
Distance from floor to center of bottom tapping.		4½	4½	4½	4½	3	3

Detailed measurements are given on page 190.

*Add ½-inch to length for each bushing.

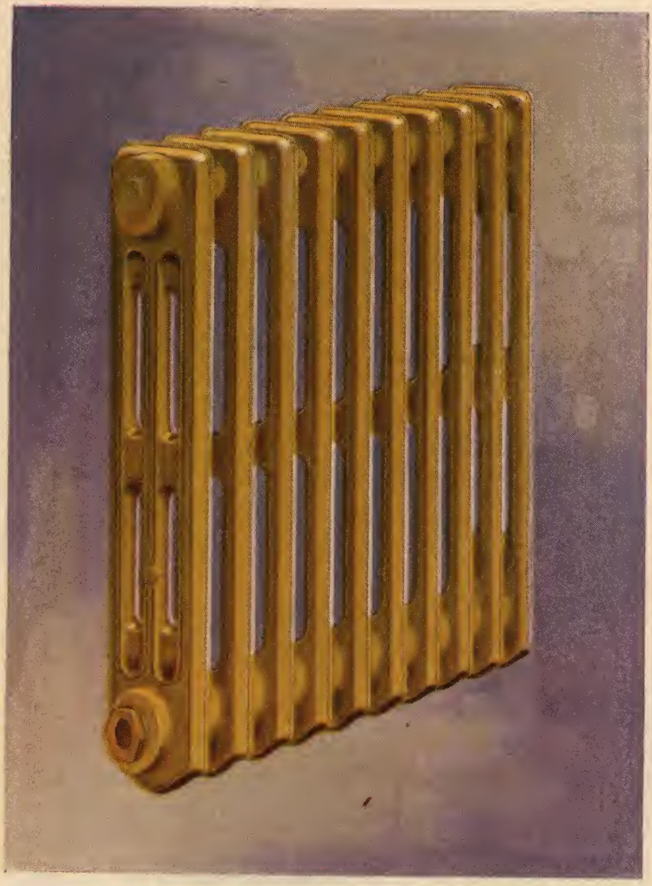
Width of feet, 12 inches. Width of section, 12 inches.

Tapped 1½ inches top and bottom both ends and bushed to sizes required.

Can be furnished legless or with 6 inch high legs on all six heights also 4½ inch high legs on 16½ inch and 13½ inch heights.

To determine the overall height of the 7-tube legless radiators deduct 2⅛ inches from the standard height except on the 13½ inch and 16½ inch heights in which case ¾ of an inch should be deducted. See page 186, 190 for legless data.

NATIONAL AERO LEGLESS TYPE RADIATION



Aero Legless Radiators are made up in three, four, five, six and seven-tube models. See pages 177 to 185 for sizes and ratings; 190 for overall heights. They are hung on the wall, out of the way. There are no legs to interfere with cleaning. Their usefulness is apparent in hospitals, bathrooms, kitchens and fully carpeted rooms.

The unobtrusive beauty of National Panel Radiation makes it a decorative unit that actually enhances the appearance of the room. See pages 210 to 221 for data and dimensions.

Aero Wall Radiation is extensively used in factories, storehouses, garages, bathrooms, halls, schools and similar applications, because of its ability to provide maximum heat in a restricted space. The Aero Bathroom Radiator (lower illustration) was especially designed for use in apartment and hotel bath rooms.

Maximum . . .
warmth—with minimum space

NATIONAL Aero Wall Radiators are made up in sections and in a variety of sizes. This permits of assemblage into numerous grouping arrangements to fit into spaces of practically any size or shape—under windows, or between them—on walls or ceilings.

To secure maximum heating efficiency, Aero Wall Radiation should always be assembled with bars vertical. It is made in two types to facilitate this in various assemblages. The 7A and 9A types have bars running the short way of the section and the 7B and 9B types have bars running the long way of the section.

Complete dimensions and assemblies are shown on pages 192 to 199 inclusive.

Aero Bathroom Radiator

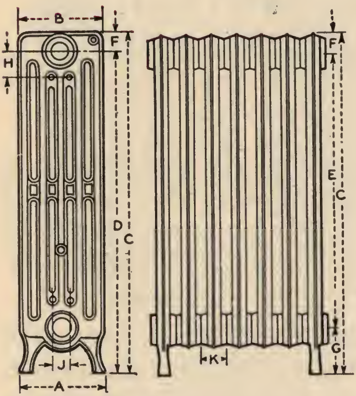
These radiators are furnished in single sections, rated at 3½ square feet per section. They are tapped ½ inch top and bottom both ends.

Dimensions: Length $20\frac{7}{16}$ inches, Height $8\frac{13}{32}$ inches, Thickness $1\frac{13}{16}$ inches. Center to center of tappings $6\frac{13}{32}$ inches.

AERO TUBE-TYPE RADIATION

Dimensions

See table on opposite page for measurements.



Distance from Floor to Center of Lower Tapping

Number of Tubes	Heights	"G"
3 Tube	All	4½″
4 Tube	All	4½″
5 Tube	All	4½″
6 Tube	All	4½″
7 Tube	36″	4½″
"	30″	4½″
"	26″	4½″
"	20″	4½″
"	16½″	3″
"	13½″	3″

A. Width of feet.
B. Width of section.
C. Total height.
D. Distance from floor to center of top tapping.
E. Distance from center of top tapping to center of bottom tapping.
F. Distance from top of radiator to center of top tapping.
G. Distance from floor to center of bottom tapping.
H. Distance from center of top tapping to center of rod holes.
J. Center to center distance between rod holes.
K. Center to center distance between sections, 2½ inches.

Can be furnished with high legs, making distance from floor to center of bottom tapping 6 inches in all heights including 16½″ and 13½″ 7 Tube. 16½″ and 13½″ 7 Tube heights can also be furnished with high legs making distance from floor to center of bottom tapping 4½″.

Aero Legless Radiation

Overall Height 3, 4, 5 and 7 Tubes

Standard Height— 36″ – 30″ – 26″ – 23″ – 20″ –16½″–13½″
Legless Height— 33⅞″–27⅞″–23⅞″–20⅞″–17⅞″–15¾″–12¾″

6 Tube

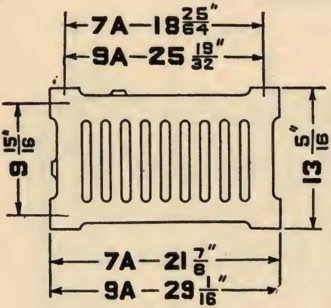
Standard Height— 38″ – 32″ – 26″ – 23″ – 20″
Legless Height— 35½″–29½″–23½″–20½″–17½″

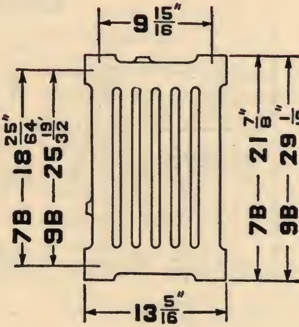
Dimensions

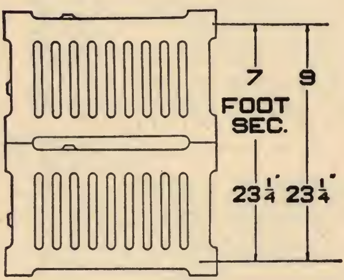
Dimensions are in Inches. See Outline Drawing on Opposite Page

AERO	Height	A	B	C	D	E	F	H	J
3 Tube	20"	5 3/32"	5 3/32"	19 25/32"	17 27/32"	13 11/32"	1 15/16"	2 9/16"	1 15/16"
	23"	5 3/32"	5 3/32"	22 3/4"	20 13/16"	16 5/16"	1 15/16"	2 9/16"	1 15/16"
	26"	5 3/32"	5 3/32"	25 49/64"	23 53/64"	19 21/64"	1 15/16"	2 9/16"	1 15/16"
	30"	5 3/32"	5 3/32"	29 25/32"	27 27/32"	23 11/32"	1 15/16"	2 9/16"	1 15/16"
	36"	5 3/32"	5 3/32"	35 23/32"	33 25/32"	29 9/32"	1 15/16"	2 9/16"	1 15/16"
4 Tube	20"	6 51/64"	6 51/64"	19 25/32"	17 27/32"	13 11/32"	1 15/16"	2 1/32"	3 21/32"
	23"	6 51/64"	6 51/64"	22 3/4"	20 13/16"	16 5/16"	1 15/16"	2 1/32"	3 21/32"
	26"	6 51/64"	6 51/64"	25 49/64"	23 53/64"	19 21/64"	1 15/16"	2 1/32"	3 21/32"
	30"	6 51/64"	6 51/64"	29 25/32"	27 27/32"	23 11/32"	1 15/16"	2 1/32"	3 21/32"
	36"	6 51/64"	6 51/64"	35 23/32"	33 25/32"	29 9/32"	1 15/16"	2 1/32"	3 21/32"
5 Tube	20"	8 13/32"	8 13/32"	19 25/32"	17 27/32"	13 11/32"	1 15/16"	2 19/32"	1 11/16"
	23"	8 13/32"	8 13/32"	22 3/4"	20 13/16"	16 5/16"	1 15/16"	2 19/32"	1 11/16"
	26"	8 13/32"	8 13/32"	25 49/64"	23 53/64"	19 21/64"	1 15/16"	2 19/32"	1 11/16"
	30"	8 13/32"	8 13/32"	29 25/32"	27 27/32"	23 11/32"	1 15/16"	2 19/32"	1 11/16"
	36"	8 13/32"	8 13/32"	35 23/32"	33 25/32"	29 9/32"	1 15/16"	2 19/32"	1 11/16"
6 Tube	20"	9"	9"	19 27/32"	17 29/32"	13 13/32"	1 15/16"	2 3/16"	3 3/16"
	23"	9"	9"	22 39/64"	20 43/64"	16 11/64"	1 15/16"	2 3/16"	3 3/16"
	26"	9"	9"	25 55/64"	23 59/64"	19 27/64"	1 15/16"	2 3/16"	3 3/16"
	32"	9"	9"	31 55/64"	29 59/64"	25 27/64"	1 15/16"	2 3/16"	3 3/16"
	38"	9"	9"	37 27/32"	35 29/32"	31 13/32"	1 15/16"	2 3/16"	3 3/16"
7 Tube	13 1/2"	12"	12"	13 21/64"	11 25/64"	8 25/64"	1 15/16"	2 15/32"	1 23/32"
	16 1/2"	12"	12"	16 19/64"	14 23/64"	11 23/64"	1 15/16"	2 15/32"	1 23/32"
	20"	12"	12"	19 25/32"	17 27/32"	13 11/32"	1 15/16"	2 15/32"	1 23/32"
	26"	12"	12"	25 49/64"	23 53/64"	19 21/64"	1 15/16"	2 15/32"	1 23/32"
	30"	12"	12"	29 25/32"	27 27/32"	23 11/32"	1 15/16"	2 15/32"	1 23/32"
	36"	12"	12"	35 23/32"	33 25/32"	29 9/32"	1 15/16"	2 15/32"	1 23/32"

NATIONAL AERO WALL RADIATION

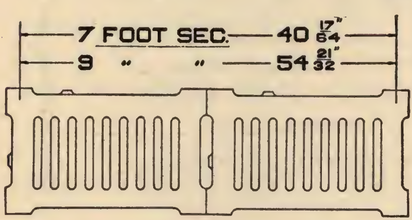






Dimensions

Regular tappings are indicated by letters A, B, C, D, E, F, G and H. Special tappings which can be furnished at extra charge are indicated by numbers 10, 20, 30, 40, 50, 60, 70 and 80. Tappings are 1½", supply and return, and bushed as desired.



Add 1⅛" to length measurement for each hexagon nipple used in assembling. The sections are connected with right and left internal threaded nipples, provided with two heavy inside lugs.

All orders should refer to figure number showing assembly or be accompanied by sketch.

Table Showing Length of Space Occupied-And Heating Surface

For Various Sizes and Assemblages of Aero Wall Radiators.

No. of Sections	Length of Space Occupied			Heating Surface, Square Feet	
	Type 7-A Ft. In.	Type 9-A Ft. In.	Types 7-B, 9-B Ft. In.	Type 7	Type 9
1	1— 9⅞	2— 5 1/16	1— 1 5/16	7	9
2	3— 7¾	4—10 ⅛	2— 2 ⅝	14	18
3	5— 5⅝	7— 3 3/16	3— 3 15/16	21	27
4	7— 3½	9— 8 ¼	4— 5 ¼	28	36
5	9— 1⅜	12— 1 5/16	5— 6 9/16	35	45
6	10—11¼	14— 6 ⅜	6— 7 ⅞	42	54
7	12— 9⅛	16—11 7/16	7— 9 3/16	49	63
8	14— 7	19— 4 ½	8—10 ½	56	72
9	16— 4⅞	21— 9 9/16	9—11 13/16	63	81
10	18— 2¾	24— 2 ⅝	11— 1 ⅛	70	90
11	20— 0⅝	26— 7 11/16	12— 2 7/16	77	99
12	21—10½	29— 0 ¾	13— 3 ¾	84	108
13	23— 8⅜	31— 5 13/16	14— 5 1/16	91	117
14	25— 6¼	33—10 ⅞	15— 6 ⅜	98	126
15	27— 4⅛	36— 3 15/16	16— 7 11/16	105	135
16	29— 2	38— 9	17— 9	112	144
17	30—11⅞	41— 2 1/16	18—10 5/16	119	153
18	32— 9¾	43— 7 ⅛	19—11 ⅝	126	162
19	34— 7⅝	46— 0 3/16	21— 0 15/16	133	171
20	36— 5½	48— 5 ¼	22— 2 ¼	140	180
21	38— 3⅜	50—10 5/16	23— 3 9/16	147	189
22	40— 1¼	53— 3 ⅜	24— 4 ⅞	154	198
23	41—11⅛	55— 8 7/16	25— 6 3/16	161	207
24	43— 9	58— 1 ½	26— 7 ½	168	216
25	45— 6⅞	60— 6 9/16	27— 8 13/16	175	225
26	47— 4¾	62—11 ⅝	28—10 ⅛	182	234

To these lengths add ½ inch for each end bushed and 1⅛ inches for each Hexagon Nipple used in assembling.

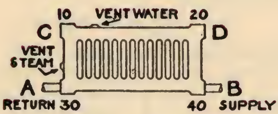


Fig. 2. Water and One and Two-Pipe Steam

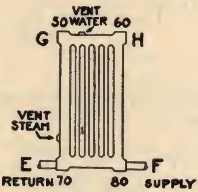


Fig. 1. Water and One and Two-Pipe Steam

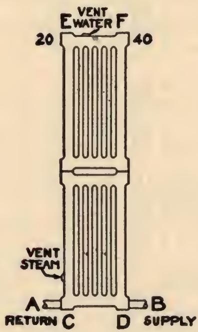


Fig. 7. Two Sections in Two Tiers — Water and One and Two-Pipe Steam

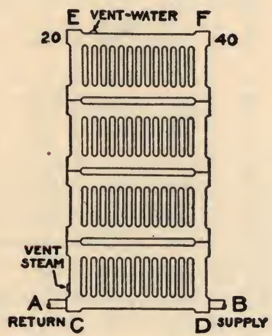


Fig. 9. Four Sections in Four Tiers — Water and One and Two-Pipe Steam

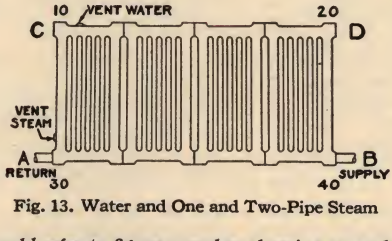


Fig. 13. Water and One and Two-Pipe Steam

All orders should refer to figure number showing assembly or be accompanied by sketch.

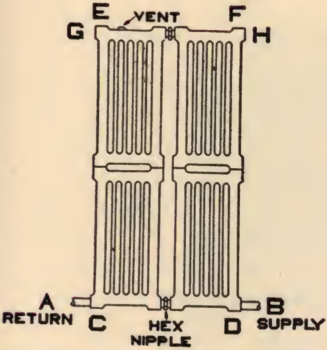


Fig. 5. Four Sections in Two Tiers — Water

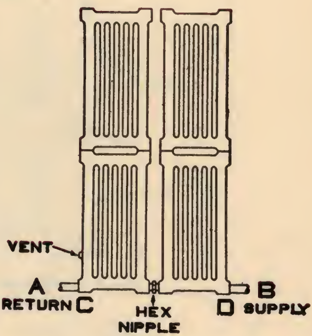


Fig. 6. Four Sections in Two Tiers — One and Two-Pipe Steam

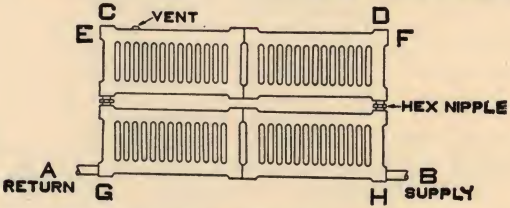


Fig. 9½. Four Sections in Two Tiers—Water

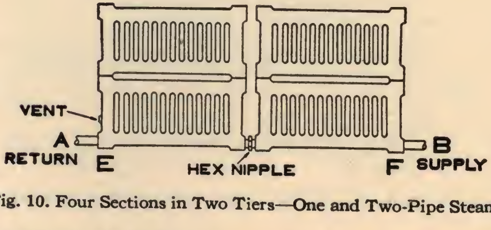


Fig. 10. Four Sections in Two Tiers—One and Two-Pipe Steam

All orders should refer to figure number showing assembly or be accompanied by sketch.

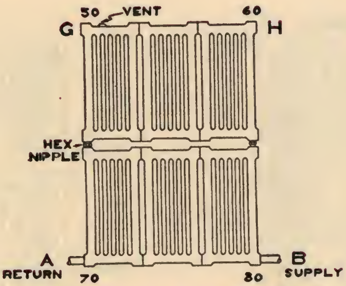


Fig. 8. Six Sections in Two Tiers—Water

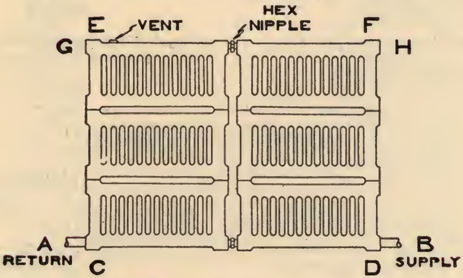


Fig. 11. Six Sections in Three Tiers—Water

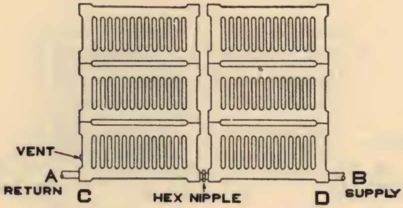


Fig. 12. Six Sections in Three Tiers—One and Two-Pipe Steam

All orders should refer to figure number showing assembly or be accompanied by sketch.

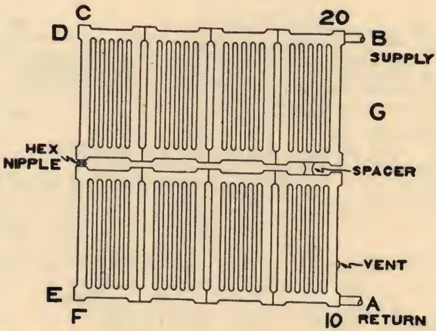


Fig. 20. Eight Sections in Two Tiers—Two-Pipe Steam Using Spacing Saddle

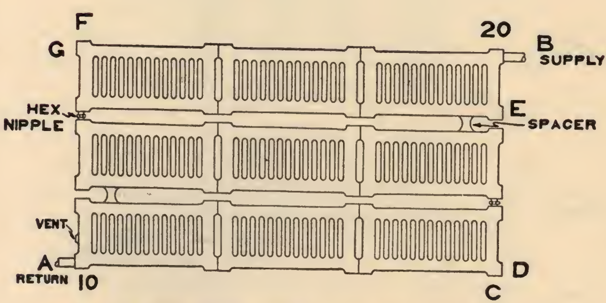


Fig. 18. Nine Sections in Three Tiers—Two-Pipe Steam

All orders should refer to figure number showing assembly or be accompanied by sketch.

Fig. 14. Water and One and Two-Pipe Steam.

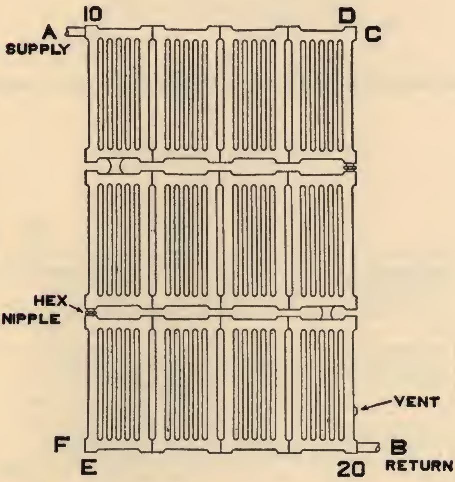


Fig. 19. Twelve Sections in Three Tiers—Two-Pipe Steam

All orders should refer to figure number showing assembly or be accompanied by sketch.

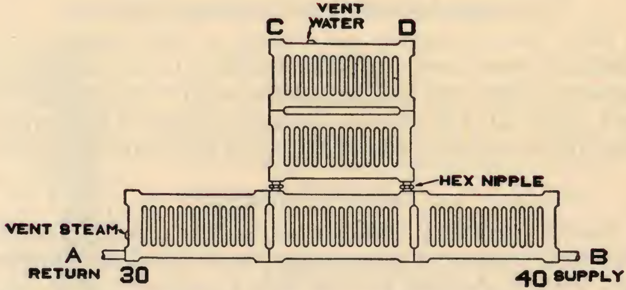


Fig. 15. Three and Two Sections with Three Tiers in Center—Water and One and Two-Pipe Steam

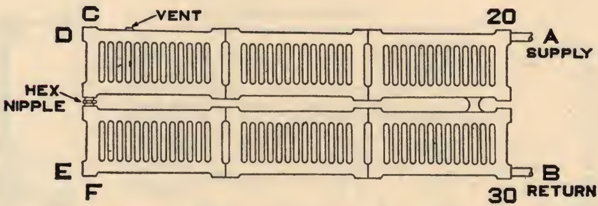


Fig. 16. Six Sections in Two Tiers—Water

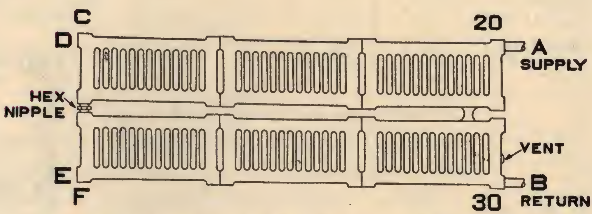


Fig. 17. Six Sections in Two Tiers—Two-Pipe Steam

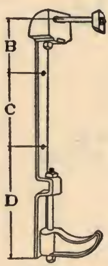
All orders should refer to figure number showing assembly or be accompanied by sketch.

National Adjustable Radiator Hangers

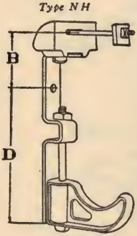
With the increasing popularity of the Legless type Radiator, has come a need for an easily installed effective support. This need has been filled by National Type MT and Type N Adjustable Radiator Hangers. (Type MT illustrated on next page and Type N is illustrated below).

Type N Hangers

Easily installed, effective supports, which eliminate the need for precise measurements in installing hangers, and permit shifting the radiator's position. The Type N has a steel back with cast fittings. It is made in two sizes—the NH for high radiators and the NL for low radiators.



Type NH



Type NL

Measurements

Radiator Height	B	C	D
38″	2¾″	7″	9½″
36″	2¾″	7″	9½″
32″	2¾″	7″	9½″
30″	2¾″	7″	9½″
26″	3¾″		8½″
23″	3¾″		8½″
20″	3¾″		8½″

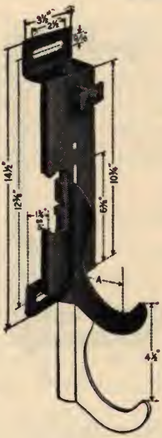
Fastened with ⅜ inch lag screws or bolts (not furnished with hangers).

When ordering hangers specify type desired, also the height of the radiator and number of tubes.

Type NH
For 38″,36″,32″ and 30″ High Radiators

Type NL
For 26″, 23″ and 20″ High Radiator

Type MT Adjustable Hanger

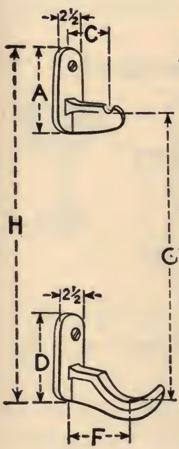


These hangers are fastened to the wall by means of anchor bolts furnished with the hangers. Type MT hangers are adjustable $2\frac{1}{2}$ in. horizontally and $4\frac{1}{2}$ inches vertically.

"A" Measurements Type MT

3 tube	$2\frac{17}{32}''$
4 tube	$3\frac{13}{32}''$
5 tube	$4\frac{5}{32}''$
6 tube	$4\frac{1}{2}''$
7 tube	$6''$

Type X Concealed Hangers



No. Tubes	Top—Inches		Dimensions—"G"—Inches						
	A	C	38	36	32	30	26	23	20
3	$4\frac{3}{8}$	$2\frac{5}{8}$	......	$28\frac{1}{8}$	......	$22\frac{1}{8}$	$18\frac{1}{8}$	$15\frac{1}{8}$	$12\frac{1}{8}$
4	$4\frac{3}{8}$	$2\frac{5}{8}$	......	$28\frac{1}{16}$	......	$22\frac{11}{16}$	$18\frac{11}{16}$	$15\frac{11}{16}$	$12\frac{11}{16}$
5	6	$4\frac{5}{16}$	......	$28\frac{1}{8}$	......	$22\frac{1}{8}$	$18\frac{1}{8}$	$15\frac{1}{8}$	$12\frac{1}{8}$
6	6	$6\frac{1}{2}$	$29\frac{15}{16}$	.....	$23\frac{15}{16}$	......	$17\frac{15}{16}$	$14\frac{15}{16}$	$11\frac{15}{16}$
7	6	$6\frac{3}{16}$	......	$28\frac{1}{8}$	......	$22\frac{1}{8}$	$18\frac{1}{8}$	.....	$12\frac{1}{8}$

No. Tubes	Bottom—Inches		Dimensions—"H"—Inches						
	D	F	38	36	32	30	26	23	20
3	$4\frac{3}{8}$	$3\frac{1}{2}$	......	32	......	26	22	19	16
4	6	$4\frac{13}{32}$	......	$32\frac{3}{4}$	......	$26\frac{3}{4}$	$22\frac{3}{4}$	$19\frac{3}{4}$	$16\frac{3}{4}$
5	6	$5\frac{1}{8}$	......	$33\frac{1}{8}$	......	$27\frac{1}{8}$	$23\frac{1}{8}$	$20\frac{1}{8}$	$17\frac{1}{8}$
6	$6\frac{1}{4}$	$6\frac{1}{2}$	$35\frac{7}{16}$	.....	$29\frac{7}{16}$	......	$23\frac{7}{16}$	$20\frac{7}{16}$	$17\frac{7}{16}$
7	$6\frac{1}{4}$	7	......	$33\frac{7}{16}$	......	$27\frac{7}{16}$	$23\frac{7}{16}$	.....	$17\frac{7}{16}$

Adjustable Wall Hangers

No. 25 No. 20 No. 21

No. 20—21—25—Combination Top and Bottom Brackets (Adjustable)—Steel and Iron—Require ⅜ Inch Lag Screws (not furnished with hanger.)

Number of Adjustable Hangers Required

No. 20 Single

5 to 12	Sections	inclusive	2	Hangers
13 to 18	"	"	3	"
19 to 25	"	"	4	"
26 and 30	"	"	5	"

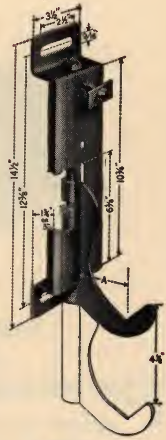
No. 21 Double

5 to 8	Sections	inclusive	2	Hangers
9 to 14	"	"	4	"
15 to 24	"	"	6	"
25 to 32	"	"	8	"

NATIONAL WALL RADIATOR HANGERS

Adjustable Hangers—Type MW.

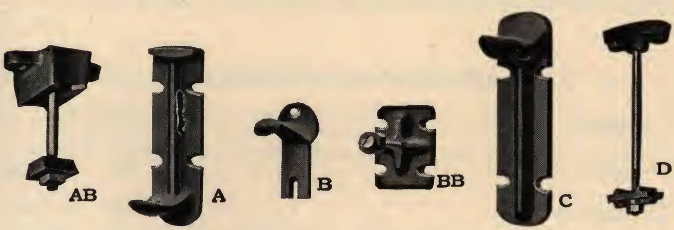
Type MW hangers are fastened to the wall by means of anchor bolts furnished with the hangers. Type MW hangers are adjustable $2\frac{1}{2}$ inches horizontally and $4\frac{1}{2}$ inches vertically. The "A" measure ment is $1\frac{1}{2}$ inches.



MW Hanger

Concealed Hangers

Hanger A is screwed to wall, baseboard or wainscoting, and supports all sizes of wall radiators. Hangers B and BB are screwed to wall, baseboard or wainscoting and intended to be used as a guide or to hold in position radiator supported by bracket A or C. The BB bracket is slotted for four and the B bracket for two wood screws, not supplied with hangers. With each BB bracket one one-quarter inch stove bolt and button is furnished.



Hanger D—Steel and Iron, is screwed to the ceiling with No. 14 screws (not furnished with hanger.)

Hanger AB is screwed to the wall, baseboard or wainscoting and supports the Aero Bathroom Radiator.

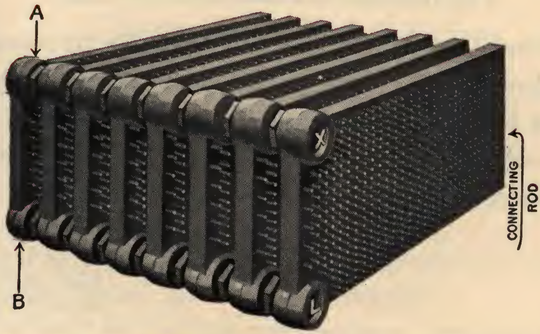
Aero Prime Indirect Radiation

PRIME Indirect Radiators are designed for the use of either steam or water. Each section has a radiation capacity of 15 square feet. Sections are assembled at factory and shipped complete unless ordered "knocked down." An additional charge is made for assembling Prime Indirect Radiation, as shown in Trade Price Sheet.

Dimensions of Sections

Length	36½	inches
Height	10	inches
Thickness	4	inches

Sections are connected with No. 3 extra heavy malleable iron slip nipples. End sections are regularly tapped 2 inches and bushed to required size.



Stack of Eight Sections showing special connecting rod

Aero Pin Indirect Radiation

THESE radiators are made in 15- and 20-foot sections in water pattern only; tapped for steam when so ordered.

End sections are regularly tapped 2 inches at "X" and "L" (see illustration); right hand thread at the supply end and left hand at the return end. The air valve tapping is $\frac{3}{8}$ inch.

Special $1\frac{1}{4}$ inch tappings can be furnished at A and B (see illustration) when so ordered. An extra charge will be made for these special tappings, as shown in the Trade Price Sheet.

Pin Indirect Radiation (continued)

Connections between sections are made by means of extra heavy 2-inch right and left hand threaded nipples having hexagon nut at center. Sections are stayed by means of a draw rod running through cored openings at opposite end from nipple connection, as illustrated.

Dimensions	15-Foot Section	20-Foot Section
Length of Section	35½″	35½″
Height of Section	10¼″	14″
Height of Section at Connecting Point	11½″	15½″
Width each Section Occupies in Stack	4″	4″
Distance between Tappings X and L	8″	11½″

When ordering Pin Indirect Radiators specify number of inside sections desired, number of supply and return sections desired, and whether for steam or water (15 or 20 foot sections).

Radiators are shipped assembled unless ordered "knocked down". An extra charge for assembling will be made as shown in Trade Price Sheet.

Directions For Ordering National Aero Wall Radiation

For convenience in handling and shipping, radiators will be assembled in stacks, as follows, unless otherwise ordered. Longer assemblings are not recommended because of possibility of strain in shipment.

5 ft. Horizontal, not to exceed 6 sections
7 ft. Horizontal, not to exceed 4 sections
9 ft. Horizontal, not to exceed 3 sections
7 ft. and 9 ft. Vertical, not to exceed 7 sections

Right and left threaded nipple with hexagon nut at center furnished to enable fitter to assemble stacks having more sections than above mentioned.

Number of Adjustable Hangers Required

Single Row

5 to 12	Sections	inclusive	2	Hangers
13 to 18	"	"	3	"
19 to 25	"	"	4	"
26 to 30	"	"	5	"

Double Row

5 to 8	Sections	inclusive	2	Hangers
9 to 14	"	"	4	"
15 to 24	"	"	6	"
25 to 32	"	"	8	"

Unless order specifies the exact number required, hangers will be furnished in accordance with the above table.

National Radiation Standard Tappings

One Pipe Steam Systems

0 to 24 square feet inclusive	1 inch
25 to 60 square feet inclusive	1¼ inch
61 square feet and above	1½ inch

Two Pipe Steam Systems

0 to 48 square feet inclusive	1 x ¾ inch
49 to 96 square feet inclusive	1¼ x 1 inch
Over 96 square feet	1½ x 1¼ inch

Hot Water Systems

0 to 40 square feet inclusive	1 x 1 inch
41 to 72 square feet inclusive	1¼ x 1¼ inch
Over 72 square feet	1½ x 1½ inch

(This table is not intended to cover closed systems or the practice in some localities of using ¾ inch on upper floor radiators.)

Standard Tappings, (continued)

Vapor And Vacuum Systems

Unless otherwise specified, all radiators for vapor will be tapped top and bottom at opposite ends as follows:

0 to 30 square feet inclusive	½ x ½ inch
31 to 60 square feet inclusive	¾ x ½ inch
61 to 120 square feet inclusive	1 x ½ inch
121 to 200 square feet inclusive	1¼ x ½ inch
Over 200 square feet	1½ x ¾ inch

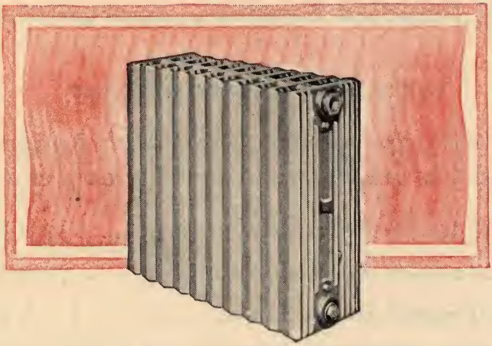
(Return tappings eccentric.)

Radiator Tappings

All tube radiators are tapped 1½ inches at top and at bottom right hand and bushed to the required size. All wall radiators are tapped 1½ inches right hand on the supply end, 1½ inches left hand on the return end and bushed to the size required.

All air vents are ⅛ inch, located at the top for water, and two-thirds down the return end section for steam. Air vents are plugged and eccentric bushings are furnished ONLY upon request.

Unless otherwise ordered all National Radiators will be bushed in accordance with above schedule.



National Panel Radiation (5-Tube)

IN designing Panel-Rad (Registered Trade Mark) the National Radiator Corporation successfully coordinated three divergent and desirable qualities, to produce a unit that meets every requirement.

National Panel Radiation is unobtrusive; only its pleasingly smooth face is visible.

National Panel Radiation is space saving; when fully recessed it occupies no floor space whatever, leaves the room clear for furniture and fittings.

National Panel Radiation is highly efficient; the convection air currents progress unimpeded and at high velocity through specially designed flues which present a maximum of heating surface, and promote quick and continuous heat transfer. There is also a large percentage of radiated heat.

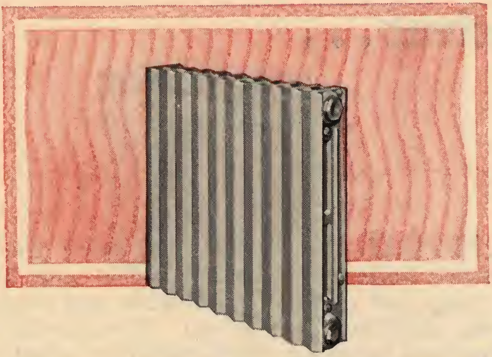
Efficient . . .

space saving
unobtrusive

NATIONAL Panel-Rad (registered trade-mark name) finds its particular field in large buildings, where every foot of space is valuable and every means of saving space must be utilized. It is likewise of value for homes and hospitals. High efficiency, a high percentage of radiated heat which warms the lower portion of the room rapidly, and the decorative effect presented by the solid metal panel recommend it for all applications.

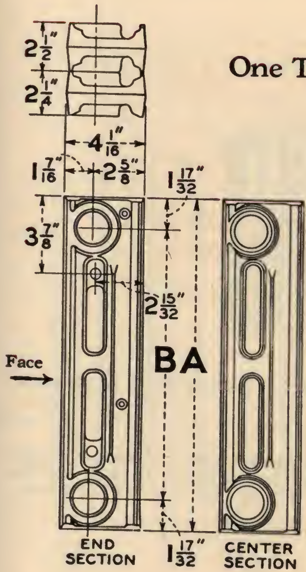
One advantage of National Panel-Rad is found in the fact that its closed end sections permit it to be recessed or wall mounted, without the necessity of entirely enclosing the unit. The radiation may be fully enclosed in a sheet metal casing with a grill at the bottom and the top, or the grill at the bottom may be omitted, or no casing need be used at all. When the radiator is recessed it is advisable to insulate the recess with asbestos or cork board.

National Panel-Rad owes its attractiveness to the fact that front faces of the sections come together, making an uninterrupted, iron-to-iron contact, and presenting therefore a uniform and pleasing appearance. This is made possible through National's use of push nipples, permitting the sections to be assembled tightly and permanently and without the use of gaskets.



One Tube Panel Radiation—Sizes and Ratings

Number of Sections	Length Overall Inches	17-Inch Height 1¾ Square Feet Per Section	23-Inch Height 2¼ Square Feet Per Section
2	4½	3½	4½
3	7	5¼	6¾
4	9½	7	9
5	12	8¾	11¼
6	14½	10½	13½
7	17	12¼	15¾
8	19½	14	18
9	22	15¾	20¼
10	24½	17½	22½
11	27	19¼	24¾
12	29½	21	27
13	32	22¾	29¼
14	34½	24½	31½
15	37	26¼	33¾
16	39½	28	36
17	42	29¾	38¼
18	44½	31½	40½
19	47	33¼	42¾
20	49½	35	45
21	52	36¾	47¼
22	54½	38½	49½
23	57	40¼	51¾
24	59½	42	54
25	62	43¾	56¼



One Tube Panel Radiation

Dimensions

Radiator Size	A	B
17-inch	17″	13$^{15}/_{16}$″
23-inch	22¾″	19$^{11}/_{16}$″

Tappings—1½ inch top and bottom both ends. Bushed to meet requirements.

Connections—Assembled with extra heavy Malleable Iron Push Nipples.

Vents—All Panel Radiators regularly furnished with Steam and Water Vents.

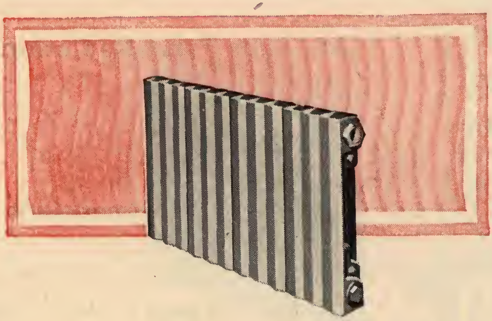
Note: Distance from top of radiator to center of ½ inch diameter top rod hole—3⅞ inches. Rod hole is $^5/_{32}$″ off center line of nipple opening.

Add ½ inch to length for each bushing.

Guaranteed Heat Emission of 240 B. T. U. per Square Foot listed rating in room temperature of 70° F. with Steam at 215° F.

Interchangeable for Steam or Water.

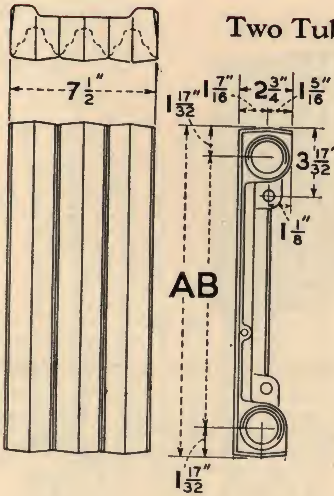
Detail of hangers furnished on request.



Two Tube Panel Radiation—Sizes and Ratings

Number of Sections	Length Overall Inches	17-Inch Height 3 1/3 Square Feet Per Section	23-Inch Height 4 1/4 Square Feet Per Section
2	15	6 2/3	8½
3	22½	10	12¾
4	30	13 1/3	17
5	37½	16 2/3	21¼
6	45	20	25½
7	52½	23 1/3	29¾
8	60	26 2/3	34
9	67½	30	38¼
10	75	33 1/3	42½
11	82½	36 2/3	46¾
12	90	40	51
13	97½	43 1/3	55¼
14	105	46 2/3	59½
15	112½	50	63¾
16	120	53 1/3	68

Two Tube Panel Radiation



Dimensions

Radiator Size	A	B
17-inch	17″	13$^{15}/_{16}$″
23-inch	22¾″	19$^{11}/_{16}$″

Tappings—1½ inch top and bottom both ends. Bushed to meet requirements.

Connections—Assembled with extra heavy Malleable Iron Push Nipples.

Vents—All Panel Radiators regularly furnished with Steam and Water Vents.

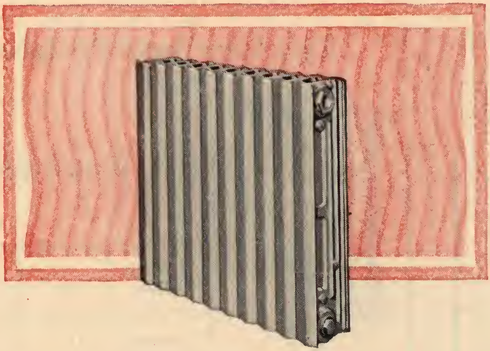
Note: Distance from top of radiator to center of ½ inch diameter top rod hole—3$^{17}/_{32}$ inches.

Add ½ inch to length for each bushing.

Guaranteed Heat Emission of 240 B. T. U. per Square Foot listed rating in room temperature of 70° F. with Steam at 215° F.

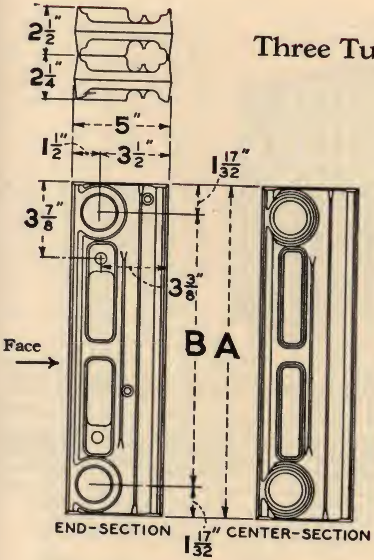
Interchangeable for Steam or Water.

Detail of hangers furnished on request.



Three Tube Panel Radiation—Sizes and Ratings

Number of Sections	Length Overall Inches	17-Inch Height 2 Square Feet Per Section	20-Inch Height 2⅓ Square Feet Per Section	23-Inch Height 2⅔ Square Feet Per Section
2	4½	4	4⅔	5⅓
3	7	6	7	8
4	9½	8	9⅓	10⅔
5	12	10	11⅔	13⅓
6	14½	12	14	16
7	17	14	16⅓	18⅔
8	19½	16	18⅔	21⅓
9	22	18	21	24
10	24½	20	23⅓	26⅔
11	27	22	25⅔	29⅓
12	29½	24	28	32
13	32	26	30⅓	34⅔
14	34½	28	32⅔	37⅓
15	37	30	35	40
16	39½	32	37⅓	42⅔
17	42	34	39⅔	45⅓
18	44½	36	42	48
19	47	38	44⅓	50⅔
20	49½	40	46⅔	53⅓
21	52	42	49	56
22	54½	44	51⅓	58⅔
23	57	46	53⅔	61⅓
24	59½	48	56	64
25	62	50	58⅓	66⅔



Three Tube Panel Radiation

Dimensions

Radiator Size	A	B
17-inch	17″	13 15/16″
20-inch	20″	16 15/16″
23-inch	22¾″	19 11/16″

Tappings—1½ inch top and bottom both ends. Bushed to meet requirements.

Connections—Assembled with extra heavy Malleable Iron Push Nipples.

Vents—All Panel Radiators regularly furnished with Steam and Water Vents.

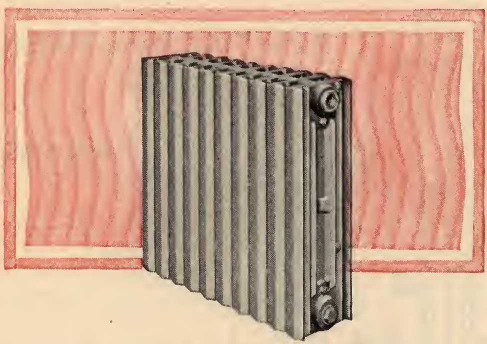
Note: Distance from top of radiator to center of ½ inch diameter top rod hole—3⅞ inches. Rod hole is ⅛″ off center line of nipple opening.

Add ½ inch to length for each bushing.

Guaranteed Heat Emission of 240 B. T. U. per Square Foot listed rating in room temperature of 70° F. with Steam at 215° F.

Interchangeable for Steam or Water.

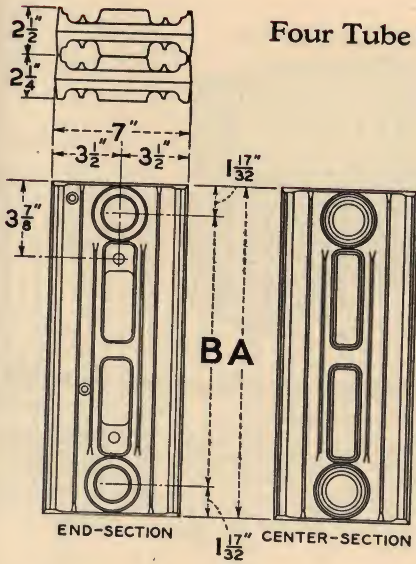
Detail of hangers furnished on request.



Four Tube Panel Radiation—Sizes and Ratings

Number of Sections	Length Overall Inches	17-Inch Height 2⅔ Square Feet Per Section	20-Inch Height 3 Square Feet Per Section	23-Inch Height 3⅓ Square Feet Per Section
2	4½	5⅓	6	6⅔
3	7	8	9	10
4	9½	10⅔	12	13⅓
5	12	13⅓	15	16⅔
6	14½	16	18	20
7	17	18⅔	21	23⅓
8	19½	21⅓	24	26⅔
9	22	24	27	30
10	24½	26⅔	30	33⅓
11	27	29⅓	33	36⅔
12	29½	32	36	40
13	32	34⅔	39	43⅓
14	34½	37⅓	42	46⅔
15	37	40	45	50
16	39½	43⅔	48	53⅓
17	42	45⅓	51	56⅔
18	44½	48	54	60
19	47	50⅔	57	63⅓
20	49½	53⅓	60	66⅔
21	52	56	63	70
22	54½	58⅔	66	73⅓
23	57	61⅓	69	76⅔
24	59½	64	72	80
25	62	66⅔	75	83⅓

Four Tube Panel Radiation



Dimensions

Radiator Size	A	B
17-inch	17″	13 15/16″
20-inch	20″	16 15/16″
23-inch	22¾″	19 11/16″

Tappings—1½ inch top and bottom both ends. Bushed to meet requirements.

Connections—Assembled with extra heavy Malleable Iron Push Nipples.

Vents—All Panel Radiators regularly furnished with Steam and Water Vents.

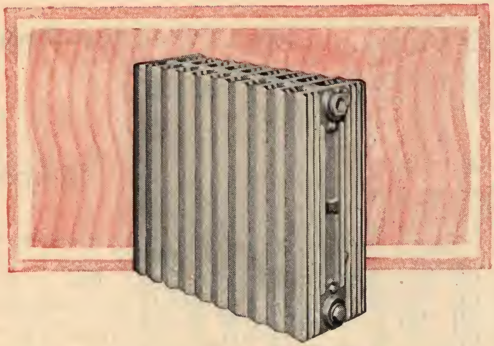
Note: Distance from top of radiator to center of ½ inch diameter top rod hole—3⅞ inches.

Add ½ inch to length for each bushing.

Guaranteed Heat Emission of 240 B. T. U. per Square Foot listed rating in room temperature of 70° F. with Steam at 215° F.

Interchangeable for Steam or Water.

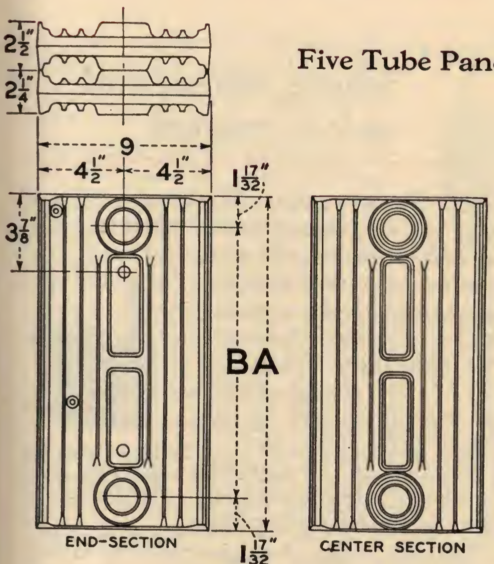
Detail of hangers furnished on request.



Five Tube Panel Radiation—Sizes and Ratings

Number of Sections	Length Overall Inches	17-Inch Height 3¼ Square Feet Per Section	23-Inch Height 4 Square Feet Per Section
2	4½	6½	8
3	7	9¾	12
4	9½	13	16
5	12	16¼	20
6	14½	19½	24
7	17	22¾	28
8	19½	26	32
9	22	29¼	36
10	24½	32½	40
11	27	35¾	44
12	29½	39	48
13	32	42¼	52
14	34½	45½	56
15	37	48¾	60
16	39½	52	64
17	42	55¼	68
18	44½	58½	72
19	47	61¾	76
20	49½	65	80
21	52	68¼	84
22	54½	71½	88
23	57	74¾	92
24	59½	78	96
25	62	81¼	100

Five Tube Panel Radiation



END-SECTION CENTER SECTION

Dimensions

Radiator Size	A	B
17-inch	17"	13 15/16"
23-inch	22¾"	19 11/16"

Tappings—1½ inch top and bottom both ends. Bushed to meet requirements.

Connections—Assembled with extra heavy Malleable Iron Push Nipples.

Vents—All Panel Radiators regularly furnished with Steam and Water Vents.

Note: Distance from top of radiator to center of ½ inch diameter top rod hole—3⅞ inches.

Add ½ inch to length for each bushing.

Guaranteed Heat Emission of 240 B. T. U. per Square Foot listed rating in room temperature of 70° F. with Steam at 215° F.

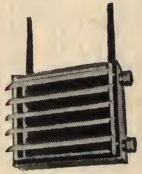
Interchangeable for Steam or Water.

Detail of hangers furnished on request.

Warmth . . .
where, when, and as it is wanted

NATIONAL Unit Heaters provide an ideal means of efficiently and quickly heating mills, factories, garages, and similar structures. The warmth is distributed uniformly through the working zone, being forced down towards the floor, instead of rising to the ceiling. Chill-zones are eliminated. An additional advantage lies in the fact that in the summer the units may be operated as recirculating fans for cooling.

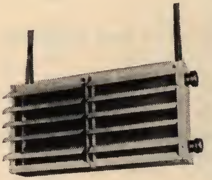
Front view No. 100; ceiling mounted with louvers.



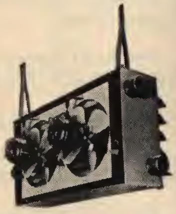
Front view No. 101, 102; ceiling mounted with louvers.

National Unit Heaters consist of copper radiator tubes, fused to steel headers. Copper fins, 1½ inch outside diameter, are imbedded in the radiator tubing, giving a positive metal-to-metal contact, and assuring maximum heat transfer. A gang of radiator tubes are installed in a jacket. A motor driven fan is attached to the rear.

The Heaters are furnished in single-fan or dual-fan units, for ceiling or wall mounting. Motors can be furnished for any ordinary voltage; single or polyphase, 25 or 60 cycles; and direct current. Constant, and variable, speed motors are available.



Front view No. 121, 131; ceiling mounted with louvers.



Rear view No. 141; ceiling mounted with louvers.

National Unit Heaters are tested under pressure of 1000 pounds to the square inch, and are guaranteed for any operating steam pressure up to 200 pounds, with the exception of the No. 100. This unit is tested to 300 pounds, and guaranteed for 150 pounds operating steam pressure.

No. 101 or 102; wall mounted outside air intake, with louvers, dampers and screen.

Installation costs, including piping, etc., are low, making these heaters economically practicable as replacement heating systems in old plants, as well as highly desirable in new buildings.

To determine the size of unit or units required for a given application, the radiation can be estimated by means of the National Direct Reading Radiation Tables. The result obtained is expressed in square feet of steam radiation required for a 70° temperature difference. For other inside temperatures, apply the "Made to Measure" heating factors, page 311.

No. 101 or 102; floor mounted recirculating box with louvers.

To obtain the hourly B.T.U.'s required, multiply the square feet of steam radiation by 240.

To compute the B.T. U. requirements directly, use the coefficients of heat transfer for various types of construction. These coefficients are shown in the building construction diagrams pages 300-307.

No. 121 or 131; floor mounted recirculating box with louvers.

National Unit Heater No. 100
Rated Capacities

1700 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–714
Total Motor H. P.—1/15 Fan H. P. .06 (60° Air)
Equivalent Direct Radiation—167

Ent. Air Temp.	Steam at 2 lbs. Gauge			Steam at 5 lbs. Gauge		
	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour
0°F.				62,000	70.8	65
50	43,200	104.7	45	45,000	106.8	47
60	40,000	111.5	41	42,000	114.2	44
70	37,100	118.7	38	39,000	121.2	41
80	34,100	125.7	35	36,000	128.3	37

1425 R. P. M.*

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–591
Total Motor H. P.—1/20 Fan H.P. .04 (60° Air)
Equivalent Direct Radiation—145

0°F.				53,900	74.4	56
50	37,500	107.2	39	39,200	109.9	41
60	34,800	114.2	36	36,600	117.0	38
70	32,200	121.0	33	33,900	123.6	35
80	29,700	127.9	31	31,200	130.3	33

1100 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–474
Total Motor H. P.—1/30 Fan H. P. .028 (60° Air)
Equivalent Direct Radiation—123

0°F.				45,600	78.4	48
50	31,700	110.3	33	33,100	113.1	34
60	29,400	117.0	30	30,900	119.9	32
70	27,200	123.7	28	28,600	126.5	30
80	25,000	130.4	26	26,500	133.4	28

810 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–357
Total Motor H. P.—1/40 Fan H. P. .022 (60° Air)
Equivalent Direct Radiation–99

0°F.				36,600	83.7	38
50	25,400	114.3	26	26,600	118.7	28
60	23,600	120.9	24	24,800	124.0	26
70	21,900	127.5	23	23,000	130.6	24
80	20,100	133.8	21	21,100	136.5	22

*25 Cycle

National Unit Heater No. 101
Rated Capacities

1750 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–1770
Total Motor H. P.—1/6 Fan H. P. .140 (60° Air)
Equivalent Direct Radiation—300

Ent. Air Temp.	Steam at 2 lbs. Gauge			Steam at 5 lbs. Gauge		
	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour
0°F.				111,500	51.3	116
50	77,500	89.5	80	81,100	91.4	84
60	72,000	97.5	74	75,600	99.3	79
70	66,600	105.3	69	70,200	107.2	73
80	61,400	113.2	64	64,900	115.1	67

1450 R. P. M.*

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–1465
Total Motor H. P.—1/8 Fan H. P. .093 (60° Air)
Equivalent Direct Radiation—259

0°F.				96,200	53.3	100
50	66,800	91.1	69	70,000	93.0	73
60	62,100	98.9	64	65,200	100.8	68
70	57,500	106.7	60	60,500	108.6	63
80	53,000	114.5	55	55,900	116.4	58

1160 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–1170
Total Motor H. P.—1/8 Fan H. P. .064 (60° Air)
Equivalent Direct Radiation—218

0°F.				81,200	56.4	85
50	56,500	93.5	58	59,000	95.4	61
60	52,400	101.1	54	55,100	103.2	57
70	48,600	108.9	50	51,100	110.9	53
80	44,700	116.4	46	47,200	118.5	49

870 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–880
Total Motor H. P.—1/10 Fan H. P. .039 (60° Air)
Equivalent Direct Radiation—175

0°F.				65,100	60.1	68
50	45,200	96.3	47	47,200	98.3	49
60	42,000	103.8	43	44,100	106.0	46
70	38,900	111.4	40	40,800	113.4	42
80	35,800	118.8	37	37,800	121.0	39

*25 Cycle

National Unit Heater No. 102
Rated Capacities

1750 R. P. M.

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–1695
Total Motor H. P.—1/6 Fan H. P. .150 (60° Air)
Equivalent Direct Radiation—417

Ent. Air Temp.	Steam at 2 lbs. Gauge			Steam at 5 lbs. Gauge		
	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour
0°F				155,000	74.4	161
50	107,800	107.3	111	112,700	109.8	117
60	100,000	114.2	104	105,000	116.8	109
70	92,600	121.1	96	97,400	123.7	101
80	85,300	128.1	88	90,100	130.7	94

1450 R. P. M.*

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–1405
Total Motor H. P.—1/8 Fan H. P. .101 (60° Air)
Equivalent Direct Radiation—363

0°F				135,200	78.4	141
50	94,000	110.3	97	98,300	113.1	102
60	87,300	117.0	90	91,600	119.9	95
70	80,800	123.8	84	85,000	126.7	88
80	74,400	130.5	77	78,600	133.4	82

1160 R. P. M.

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–1120
Total Motor H. P.—1/8 Fan H. P. .066 (60° Air)
Equivalent Direct Radiation—309

0°F				114,800	83.4	119
50	79,800	114.2	83	83,500	117.2	87
60	74,200	120.8	77	77,800	123.8	81
70	68,700	127.5	71	72,200	130.4	75
80	63,200	133.8	65	66,800	137.0	70

870 R. P. M.

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–840
Total Motor H. P.—1/10 Fan H. P. .040 (60° Air)
Equivalent Direct Radiation—248

0°F				92,200	89.2	96
50	64,100	118.7	66	67,000	121.9	70
60	59,500	125.1	62	62,500	128.4	65
70	55,100	131.4	57	58,000	134.7	60
80	50,800	137.7	53	53,600	140.9	56

* 25 Cycle

National Unit Heater No. 121
Rated Capacities

1750 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–3770
Motor H. P.—2-1/6 Fan H. P. .33 (60° Air)
Equivalent Direct Radiation–605

Ent. Air Temp.	Steam at 2 lbs. Gauge			Steam at 5 lbs. Gauge		
	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour
0°F.				224,500	48.5	234
50	156,300	87.4	161	163,400	89.1	170
60	145,000	95.4	150	152,200	97.1	158
70	134,200	103.4	139	141,100	105.1	147
80	123,700	111.3	128	130,600	113.1	136

1450 R. P. M.*

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–3130
Motor H. P.—2-1/8 Fan H. P. .225 (60° Air)
Equivalent Direct Radiation–525

0°F.				195,200	50.7	204
50	135,700	89.1	140	142,000	91.0	148
60	126,000	97.1	130	132,300	98.9	138
70	116,600	104.9	121	122,700	106.7	128
80	107,500	112.8	111	113,500	114.6	118

1160 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–2500
Motor H. P.—2-1/8 Fan H. P. .154 (60° Air)
Equivalent Direct Radiation–445

0°F.				165,700	53.8	172
50	115,200	91.6	119	120,500	93.5	126
60	107,000	99.3	111	112,300	101.3	117
70	99,000	107.2	103	104,200	109.1	109
80	91,300	114.9	94	96,400	116.8	100

870 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–1870
Motor H. P.—2-1/10 Fan H. P. .099 (60° Air)
Equivalent Direct Radiation–360

0°F.				134,000	58.4	140
50	93,200	95.0	96	97,500	97.1	102
60	86,500	102.4	90	90,800	104.7	95
70	80,100	110.0	83	84,300	112.3	88
80	73,700	117.7	76	77,900	119.8	81

*25 Cycle

National Unit Heater No. 131
Rated Capacities

1750 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–3470
Motor H. P.—2–1/6 Fan H. P. .34 (60° Air)
Equivalent Direct Radiation—800

Ent. Air Temp.	Steam at 2 lbs. Gauge			Steam at 5 lbs. Gauge		
	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour
0°F.				297,500	69.6	310
50	207,000	103.8	214	216,500	106.2	226
60	192,000	110.9	199	201,500	113.4	210
70	177,700	118.0	184	187,000	120.5	195
80	163,800	125.0	170	173,000	127.6	180

1450 R. P. M.*

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–2870
Motor H. P.—2–1/8 Fan H. P. .233 (60° Air)
Equivalent Direct Radiation—695

0°F.				258,500	73.2	269
50	180,000	106.6	186	188,000	109.1	196
60	167,000	113.5	173	175,300	116.2	183
70	154,600	120.4	160	162,700	123.1	169
80	142,300	127.4	147	150,500	130.0	157

1160 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–2290
Motor H. P.—2–1/8 Fan H. P. .156 (60° Air)
Equivalent Direct Radiation—590

0°F.				219,500	77.9	228
50	152,500	110.0	158	159,500	112.8	166
60	141,500	116.7	147	148,500	119.6	155
70	131,000	123.6	136	137,800	126.4	143
80	120,700	130.3	125	127,500	133.2	133

870 R. P. M.

Cubic Feet per Minute (70° volume) at 60° Entering Temperature–1710
Motor H. P.—2–1/10 Fan H. P. .1 (60° Air)
Equivalent Direct Radiation—475

0°F.				177,500	84.5	185
50	123,500	115.2	128	129,000	118.1	135
60	114,500	121.5	119	120,200	124.7	125
70	106,100	128.2	110	111,700	131.3	116
80	97,800	134.6	101	103,200	137.8	107

* 25 cycle

National Unit Heater No. 141
Rated Capacities

1750 R. P. M.

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–3300
Motor H. P.—2-1/6 Fan H. P. .346 (60° Air)
Equivalent Direct Radiation—983

Ent. Air Temp.	Steam at 2 lbs. Gauge			Steam at 5 lbs. Gauge		
	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour	B.T.U. per Hour	Final Temp.	Lbs. Cond. per Hour
0°F.				366,000	90.2	381
50	254,500	119.5	263	266,000	122.7	277
60	236,000	125.8	244	248,000	129.2	258
70	218,500	132.0	226	230,000	135.3	239
80	201,500	138.4	208	213,000	141.7	222

1450 R. P. M.*

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–2730
Motor H. P.—2-1/8 Fan H. P. .242 (60° Air)
Equivalent Direct Radiation—863

0°F.				320,000	95.3	333
50	223,000	123.7	240	232,500	126.9	242
60	207,000	129.7	214	217,000	133.2	226
70	191,500	135.7	198	201,000	139.0	209
80	176,000	141.5	182	186,000	145.1	193

1160 R. P. M.

Cubic Feet per Minute (70° Volume) at 60° Entering Temperature–2190
Motor H. P.—2-1/8 Fan H. P. .160 (60° Air)
Equivalent Direct Radiation—737

0°F.				274,500	102.0	286
50	191,000	128.7	197	199,500	132.2	208
60	177,000	134.3	183	186,000	138.1	194
70	164,000	140.2	169	172,500	143.8	180
80	151,000	145.8	156	159,500	149.5	166

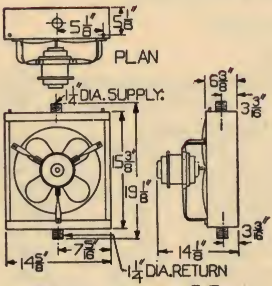
870 R. P. M.

Cubic Feet per minute (70° Volume) at 60° Entering Temperature–1645
Motor H. P.—2-1/10 Fan H. P. .101 (60° Air)
Equivalent Direct Radiation—606

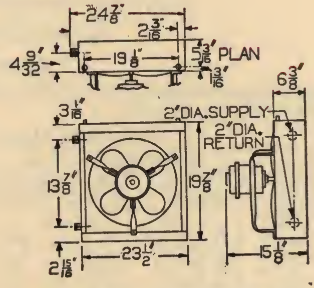
0°F.				225,000	111.5	234
50	156,500	136.0	162	163,500	139.8	170
60	145,500	141.6	150	152,500	145.6	159
70	134,500	146.9	139	141,500	150.9	147
80	124,000	152.2	128	131,000	156.2	136

*25 cycle

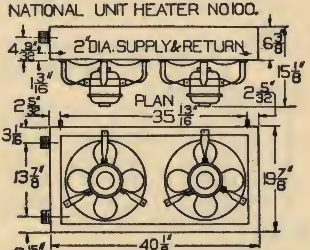
Dimensions



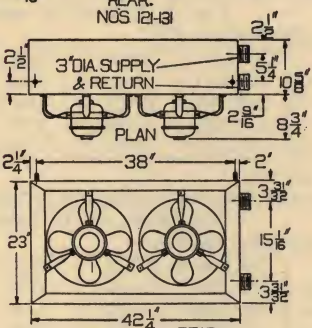
NATIONAL UNIT HEATER NO 100.



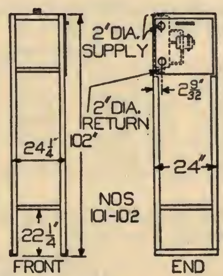
NATIONAL UNIT HEATERS NOS 101-102

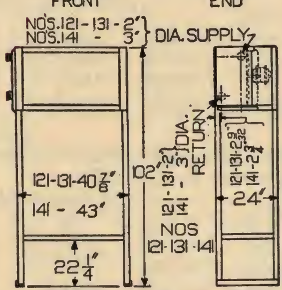


NOS 121-131



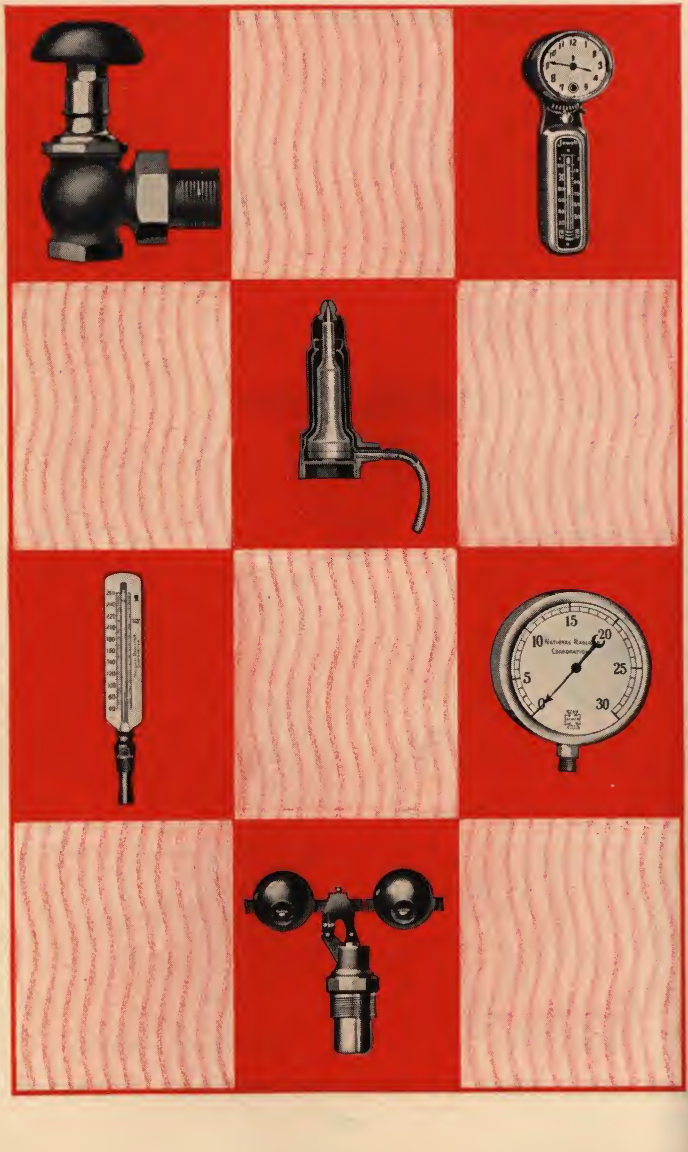
NO.-141
NATIONAL UNIT HEATERS





NATIONAL UNIT HEATERS
WITH FLOOR MOUNTING

NATIONAL HEATING ACCESSORIES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CORPORATION

Ideals . . .

Govern National Accessory Selection

THE same careful investigation is made of each new accessory that would be made of a new National Product. Exhaustive and rigorous tests are applied, or proof of them required. Manufacturing methods are checked up, and must demonstrate strict adherence to quality standards. Materials and workmanship are carefully scrutinized. Even in these products made by other manufacturers, National Ideals can be said to govern.

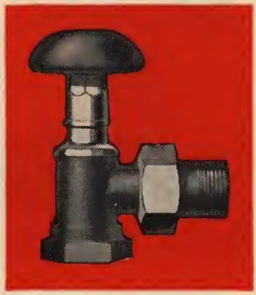
Experience has shown the wisdom of using National Heating Accessories with National Heating Systems. They have been tested together; the capabilities of each are known. In many cases, the particular type of accessory selected was chosen because of its proved ability to "team up" with the heating system, work with it in giving to the user the utmost in healthful comfort, proportioned warmth, and complete and permanent heating satisfaction.

National Sta-Pak Packless Steam Radiator Valve No. 23

THIS valve has special graphite packing, inserted under pressure, permanently seated by a spring; it never needs repacking. The special red metal body has a high percentage of copper, is compact and non-porous. Valve seat is ground; composition valve disc has long wearing qualities. The composition mushroom handle contains an embedded metal plate which takes the strains of operating; it will not warp, check, or crack under influence of heat or moisture. One turn completely opens or closes valve. The forged tail piece nut has tremendous strength that withstands abuse, and is guaranteed against breakage. Finish on valve body is "Triple-Coat" rough nickel; smooth nickel finish on other metal parts. The valve stem is short, to obviate the wabbling that often comes with wear.

No. 23 Size	½″	¾″	1″	1¼″	1½″	2″

National Sta-Pak Packless Hot Water Radiator Valve No. 24



THE sectional view below shows the ingenious and effective mechanism of this valve. The graphite packing, inserted under pressure, is permanently compressed by the action of a spring; repacking is not required. The valve body is red metal, approaching bronze in its characteristics, and containing a high percentage of copper; texture is smooth, fine and non-porous; threads are true, and free from pits and cracks. Valve contact surfaces are carefully machined. Stem is short, eliminating wabbling that often comes with use in long stems. Handle is a composition mushroom, with embedded metal plate to take strain of turning; one revolution opens and closes valve. Packing nut is annealed, and tail piece nut is forged, with great strength. It will withstand all sorts of abuse, and is guaranteed against breakage.

No. 24 Size	½″	¾″	1″	1¼″	1½″	2″

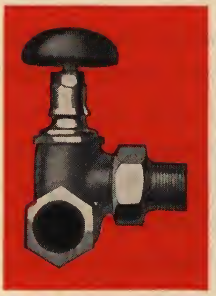
Sta-Pak Graduating Steam Valve No. 29

An adjustable metal indicating plate, graduated, accurately shows the amount the valve is opened. Stop feature, adjusted by a single screw, permits use for fractional distribution. Never needs repacking, has all the outstanding features of other Sta-Pak steam valves.

Sta-Pak Graduating Hot Water Valve No. 28

Lever operated. A pointer sweeping over a graduated indicating plate shows the amount of valve opening. Adjustable stop permits setting valve for any desired permissible opening. Never needs repacking. Has composition, finish, durability, and other outstanding features of other Sta-Pak Hot Water Valves.

Sta-Pak Steam Corner Valve No. 27



Right Hand

Red Metal, body fine-textured and free from porosity. Perfect threads. Composition mushroom handle will not warp or crack. One-turn opens and closes. Graphite packing never needs attention. Forged tail-piece nut. All right-hand threads.

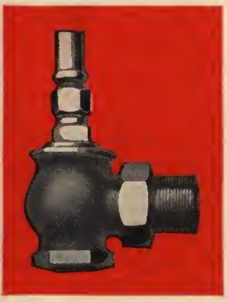
Left Hand

Sizes No. 29, 28 and 27	½″	¾″	1″	1¼″	1½″	2″

National Steam Radiator Valve No. 41

Composition handle, non-cracking, is unaffected by heat or moisture. Asbestos wick packing. Heavy metal body, rough nickel finish coat, perfect threads, strong tail piece nut.

No. 41 Size	½″	¾″	1″	1¼″	1½″	2″



National Steam Radiator Valve, with Lock Shield No. 41-L

Can be operated only by a key, retained by authorized person. Has all other features of National Steam Radiator Valve No. 41.

No. 41-L Size	½″	¾″	1″	1¼″	1½″	2″

National Hot Water Radiator Valve No. 142

Has composition handle, heavy metal body, and asbestos packing. Is carefully machined and ground.

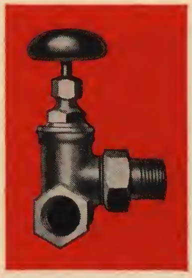
No. 142 Size	½″	¾″	1″	1¼″	1½″	2″

National Elbow Union No. 152

Has heavy body, perfect threads, ground tail piece seat, and heavy forged nut. Is strong and sturdy.

No. 152 Size	½″	¾″	1″	1¼″	1½″	2″

National Steam Corner Valve No. 52



Right Hand

Made of heavy metal with high copper content. Seat is ground. Has long-wearing composition valve disc, asbestos packing, composition handle and strong tail-piece nut to stand stresses. Furnished for hot water on order.

Left Hand

No. 52 Size	½″	¾″	1″	1¼″	1½″	2″

National Gate Radiator Valve No. 256

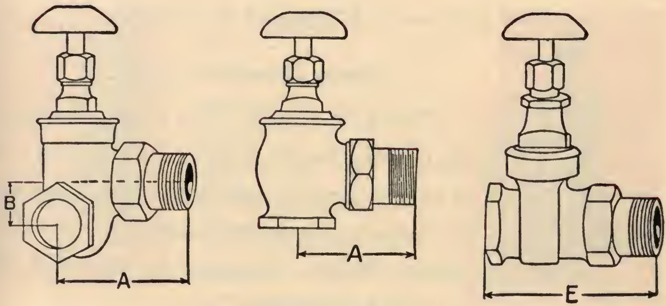
Excellent construction. Each gate is ground into its own individual valve seat on a special machine, assuring a perfect fit and high effectiveness.

No. 256 Size	½″	¾″	1″	1¼″	1½″	2″

National Globe Valve No. 260

Has heavy, non-porous, nickel finish body, ground seat, asbestos packing and composition mushroom handle.

No. 260 Size	½″	¾″	1″	1¼″	1½″	2″



National Radiator Valves

Roughing-in Measurements

These measurements cover the entire line of National Radiator Valves. The letters on the diagrams refer to corresponding letters on the table below:

Cat. No.	Size	½″	¾″	1″	1¼″	1½″	2″
Nos. 23 and 29 Packless	A	2¾	2¾	3 1/16	3 7/16	3¾	4⅜
Nos. 27 and 52 Corner	A	2¾	2 9/16	3 3/16	3 5/16	3 15/16	4½
	B	15/16	15/16	1	1 3/16	1⅝	2 3/16
Nos. 24 and 28 Packless Hot Water	A	2¾	2¾	3 1/16	3 7/16	3¾	4½
No. 41 Steam	A	2¼	2⅝	3 1/16	3 7/16	3¾	4⅜
Nos. 142 and 146 Hot Water	A	2¼	2⅝	3 1/16	3 7/16	3¾	4½
No. 152 Union Elbow	A	2¼	2½	3	3⅜	4	4⅜
No. 256 Union Gate	E	3	3½	4	4¼	4⅞	5½
No. 260 Union Globe	E	3¼	3¾	4½	5⅛	5¾	6½

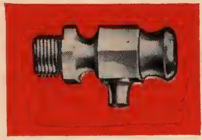
National Air Valves

Novus Automatic Air Valve

This is a competition valve, surprisingly effective in view of its low cost. It is of the carbon post type, with a brass-pin core to prevent buckling. Heavily nickel plated. Top cap is threaded to permit adjustment.

National Compression Air Valves

Wheel operated type.



Key operated type.

Key. Two furnished with each dozen valves.

These valves are made of first quality metal, finely finished, and with perfect threads. The valves are of the needle type. They are provided in either key or hand-wheel operated types.

Dole Siphon Air Valve
No. 1

Every demand of steam radiator air valves is met in this Dole No. 1. 100% Automatic—nothing to adjust or regulate. Steam enters the entire radiator without resistance. Equally efficient on steady or intermittent escape of air.

Heavy drawn brass connecting stem, riveted and brazed, 1/8″ I. P. T.

Height 3 3/8″. Diameter 1 1/8″. Stem length 3/4″.

Dole Vacuum Valve
No. 2-B

This valve performs the duty of a Siphon Air Valve and in addition holds a partial vacuum in any suitable system.

The air escapes freely thru the full size vent. Steam enters the entire radiator without resistance. When water enters the valve the float rises, and the vent is sealed. As the water siphons away the valve continues to vent.

Dole Quick Vent Air Valves

(Straight Shank)

No. 3-A, 3-B, and 3-C

For venting ends of steam mains, tanks, long mains, hot water generators and low pressure feed water heaters.

Three sizes for all popular demands.

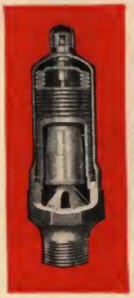
Equally efficient on steady or intermittent escape of air.

No. 3-A has ⅛″ I.P.T., No. 3-B has ¼″ I.P.T., No. 3-C has ¾″ I.P.T.

Dole Vacuum Valve

(Straight Shank)

No. 6-B



Steam heating systems equipped with vacuum valves should have Dole No. 6 Straight Shank Vacuum Valves on the mains. Assures quick venting. Vacuum feature makes one-pipe steam system more efficient.

The stem is part of the cast base—¼″ I.P.T.

National Marval Siphon Auto-Air Valves

THIS popular priced valve vents air at any temperature, closes for steam through thermostatic action, and for water through the action of a float. Self draining—cannot waterlog. Tested on steam, air, and water under actual working conditions up to 10 pounds pressure. It is adjusted, sealed to prevent tampering, and shipped ready for use on pressures up to 10 pounds on one-pipe gravity steam systems. Frees radiators of air, makes all of the radiation hot, and boosts efficiencv. The temperature of steam entering the valve instantly causes thermostatic expansion in the float—the concave diaphragm at the float bottom becomes convex—and this vertical movement forces the seating pin to seal the vent. The pressure seal continues until the steam supply ceases; whereupon the thermostatic element contracts lowering the seating pin in readiness for the next venting.

A bent length of tubing expanded within the base siphons off all condensation. This tubing is swiveled; permitting the valve to be easily screwed into place on the radiator. Guaranteed against defects for 5 years. Also furnished in straight shank style as illustrated, with 1/8″ or 1/4″ bottom connection.

Hoffman Venting and Thermostatic Valves

HOFFMAN Valves are automatic, non-adjustable and, (excepting Nos. 20 and 21) are guaranteed to function properly for a period of five years, when installed and operated under conditions for which they were designed. They are made entirely of metal, and each part of a special alloy best adapted for its particular purpose.

The basic principle used in the design of all of these valves is that of an all-metal thermostatic member, with one or more flexible diaphragms, containing a volatile or heat sensitive fluid which causes valve action upon slight temperature changes.

They have a wide range in which they operate with the same degree of accuracy, for the internal fluid pressure in the thermostatic member maintains a constant relationship with the external steam pressure throughout the whole range for which each valve is intended.

The architect, engineer and heating contractor acknowledge that heat service obtainable from a steam heating apparatus is largely dependent upon the operation of valves of this kind.

They are so designed and constructed that, without thought or attention of the user, they automatically insure flexibility and economy of operation.

No. 1 Hoffman Siphon Air Valve

For one pipe gravity systems

IT positively distinguishes between steam, air and water. The combined thermostatic member and float is a sealed metal chamber with a flexible diaphragm in the bottom, containing a volatile or heat sensitive fluid which vaporizes when the thermostat is in contact with steam, generating an internal vapor pressure which deflects the diaphragm and thereby closes the port. The vent port is kept either wide open or shut tightly with no intermediate position. Such positive action permits all air to escape until steam reaches the valve when instantaneous closure is made. It is noiseless in operation.

The float also takes care of any sudden charge of water within the radiator. Frequently a radiator while venting, "works water" causing water to surge against the air valve. The float action is so positive that as long as water remains against the valve the port is held closed. The instant water drops away, the siphon automatically discharges all the water back into the radiator without a single "spit," and venting is resumed.

No. 2 Hoffman Siphon Air and Vacuum Valve

THROUGH its use an ordinary one-pipe steam system may be changed into a vacuum type. This valve is similar in construction to the No. 1, but in addition when the radiator is once freed of air, return of air through the vent port *is prevented.*

Normally, the vent port is wide open until steam comes in contact with the valve, when the thermostatic fluid in the float expands the diaphragm and closes the vent port. When generation of steam ceases the float diaphragm contracts and the vacuum diaphragm in the base follows up the float diaphragm and holds the port tightly closed, thereby permitting a vacuum to form in the radiator because no air is permitted to return and take the place given up by the steam in condensing. If radiator is only partially heated, to prevent return of air to the system, a light air check or "automatic vacuum starter," is placed directly over the port. As soon as pressure within the radiator goes below atmospheric pressure, the check drops and temporarily retards the return of air through the vent port until a vacuum of 1″ is obtained in the radiator. Then atmospheric pressure acting through the port in the bottom of the valve, pushes the vacuum diaphragm upward and thus positively closes the port.

No. 3 Hoffman Air Line Valve

A compact, well constructed valve for Air Line, or as they are frequently termed "Paul" Systems. It is sensitive in action and closes the instant steam fills the radiator. No adjustment is necessary either before or after installation. Connections $\frac{1}{8}''$ x $\frac{1}{4}''$.

No. 4 Hoffman Quick Vent Valve

For use in venting mains, risers, Vento Stacks, Coils, etc. All air is freely vented through a $\frac{1}{8}$-inch vent port without steam loss, but valve *does not close against water*. Standard connection $\frac{3}{4}''$. $\frac{1}{4}''$ can be supplied when so ordered.

No. 5 Hoffman Quick Vent Float Air Valve

For venting all air, without steam or water loss, where water is a factor. Especially recommended for the ends of steam or dry return mains, indirect radiators, blast coils, Vento or Aerofin Stacks, hot water generators, low pressure feed water heaters, driers, drums, etc. In principle the No. 5 is the same as No. 1. $\frac{1}{16}''$ vent port standard for pressures up to 10 lbs. $\frac{3}{16}''$ port for less than 3 lbs. Supplied with $\frac{3}{8}''$ connection.

No. 6 and No. 16 Hoffman Quick Vent Float Air and Vacuum Valves

While Hoffman No. 2 Valves create a vacuum in the radiators, it is also necessary in order to completely vacuumize the system to vent and lock the air out of the mains. The No. 16 valve is recommended for this purpose except in cases where excessive amounts of water are encountered, when the No. 6 valve should be used. The No. 16 and No. 6 are suitable for use on mains, risers, and under other conditions where a quick vent is required and return of air to the system must be prevented. For venting the ends of mains where the difference between the low point of main and the water line is less than 18 inches, the No. 6 valve should always be used. For handling all conditions in one-pipe vacuum systems, the No. 6 valve is recommended. This valve has the double shell construction and operates under steam, air and water conditions in the same manner as the No. 2 vacuum valve. The No. 6 is, unless otherwise ordered, furnished with a $\frac{1}{16}$ inch port, and a $\frac{3}{8}$ inch connection. In vapor vacuum systems where pressure is less than 3 pounds, a $\frac{3}{16}$ inch port may be obtained. The No. 16 can be used on pressures up to 10 pounds. Size of port $\frac{1}{16}$ inch; connection $\frac{3}{4}$ inch.

No. 7 Hoffman Adjustable Modulating Valve

FOR use on vapor or vapor vacuum systems. Valve is made in ¾″ size, Angle Pattern only, having a range of adjustment up to 200 sq. ft. of direct cast iron radiation. Easily adjusted whether system is in operation or cold, so as to limit the flow of steam into each radiator to which it is connected.

All adjustments are external and are made by means of a visible dial which is graduated with marks indicating a port area sufficient for 10 sq. ft. of radiation. Adjustment consists of loosening a lock nut, and moving a rotary sleeve which controls the port area. The ease of adjustment, which is locked by the steamfitter, permits "balancing up" the system, or causing certain radiators to heat before others. A supplementary dial having fractional graduations, viz: SHUT, ¼, ½, ¾ and OPEN, permits the user to admit sufficient steam to fill any desired portion of the radiator and thus control room temperature.

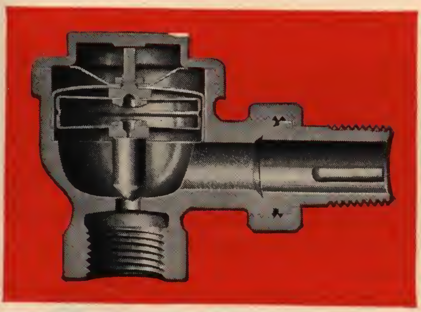
The valve stuffing box has a lubricated fibre packing that lasts indefinitely and requires no attention, at the same time giving a very free valve action.

Nos. 8 and 9 Hoffman Return Line Valves
(Or Radiator Traps)

THESE valves are installed on the return side of the radiator and permit discharge of air and condensation into the return main but close the vent port on contact with steam. Normally, the vent port is wide open and this is maintained for the discharge of air and condensation until steam fills the radiator when the port is instantly closed. Water at a temperature slightly below that of steam opens the port and permits the condensation to escape without steam loss.

Because of their wide range of operation from 0 to 50 lbs. valves may be installed in systems where steam is supplied through a reducing valve and perfect operation obtained even when reducing valve fails to function. Thermostats may be changed from one body to another of the same size as Hoffman Return Line Valves are non-adjustable. Therefore, it is easy to comply with engineer's specifications, which require removal of the thermostats while system is being cleaned.

Diaphragms are constructed of a special Hoffman alloy which resists acid corrosion, does not soften or crack under repeated action, and maintains a constant metal tension.



No. 18 Hoffman Return Line Valve

THIS valve is similar in construction and basic principle to the No. 8 Hoffman Return Line Valve. It is used where radiator units contain not over 100 sq. ft. of direct cast iron radiation, and the pressure at the trap is not in excess of 15 lbs. The thermostat consists of one chamber made by two diaphragms separated by a space ring to which they are fastened. In the center of the bottom diaphragm the valve pin is attached. The joint being expanded and soldered remains absolutely tight. The thermostat is held in its cage by a pin expanded and attached to the top diaphragm, this pin extending through the cage and engaging with the boss on the cap.

No. 19 Hoffman Radiator Valve

QUICK-OPENING, semi-packless type intended for vacuum pump installation or for vapor systems where modulation is not required. Valve is made in ¾″ size only, having a capacity up to 200 sq. ft. direct cast iron radiation; maximum operating pressure 15 lbs. It is heavily nickel-plated and has polished trimmings.

No. 19 Valve (continued)

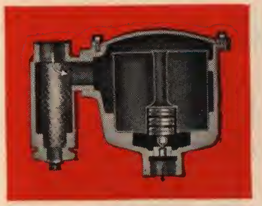
The valve stem is in one piece, the end engaging in disc holder having a quadruple thread which allows full port opening with three-quarters of a turn of handle.

The stem packing is lubricated, compressed asbestos fibre that will last indefinitely and requires no attention other than an occasional take-up of the packing nut. Handle is hard black fibre that withstands severe service without breakage. Valve disc is genuine Jenkins Bros. composition.

Regularly supplied in lever handle type. On special orders, wood wheel handles, lock shields, closed tops, chain pull or extended stems can be furnished.

No. 11 Hoffman Vapor Vacuum Valve

This valve is especially designed for venting return mains of vapor-vacuum systems, or other conditions requiring large venting capacity, without return of air to system. Vent port ¾ in. Large float prevents water leakage. Connection ¾ in.



No. 12 Hoffman Blast Trap

For draining condensation from indirect radiators, Blast, "Vento" or "Aerofin" stacks, Unit heaters, Ends of steam mains and risers, driers and drums, hot water generators, and laundry machinery. Relieves condensation immediately, regardless of its temperature, vents hot or cold air, but closes against steam. If quantity of condensation to be handled is beyond the capacity of the thermostat controlled port, float rises, opening large port. Pipe connections with strainer 1-inch inlet and outlet.

No. 13 Hoffman Damper Regulator

THE new Hoffman Damper Regulator, with its compensating or balancing plate, is like a pair of scales. It is practically frictionless, remarkably sensitive and operates on slight changes in pressure.

The compensating plate prevents the accumulation of an extra amount of water when the diaphragm is pushed downward by pressure. This makes the load on the diaphragm constant under all conditions and the result is uniformly sensitive response to slight variations in pressures.

It is automatic in operation and after it has once been set at the desired pressure requires no attention. It controls the dampers, and responds immediately when any radiator valve is turned on or off, accelerating or retarding the fire to meet the change in demand for steam from radiators. This not only assures heat but conserves fuel. It will fit any type boiler, and is equipped with lever, weights, chain and pulleys.

Connection 1 in.

Hoffman Differential Loop

TO eliminate complicated apparatus for handling condensation and returning it to the boiler it is possible in most cases to permit condensation to return by gravity. This, however, necessitates some control over the boiler water line to prevent water from leaving the boiler if a high pressure is accidentally generated.

Differential Loop

Sold as part of Controlled Heat Equipment.

Prices on Loops or basement specialties, for use otherwise, are quoted on application, and sold only when we approve plan of installation.

No. 0 and No. 02 Loops should not be used where the low point in the dry return is less than 24 in. above boiler water line. With the No. 03 and No. 04 Loop this distance must be at least 30 in.

The Hoffman Differential Loop is a simple, yet efficient, device, that provides this safeguard. It does not function under normal operation. If, however, a dangerous pressure should be generated, the Loop instantly comes into action and prevents damage to the boiler.

The Loop contains no moving parts to corrode or stick and prevent action at any time when necessary. The operation is obtained through the use of a water column which seals a connection between the steam and return mains until such time as a predetermined pressure is generated, when the connection is unsealed and a small quantity of steam is blown into the return main. This action closes the port of the main vent and compresses the air in the return sufficiently to prevent water from rising beyond the level in the return established by the predetermined pressure.

As soon as a sufficient quantity of steam is delivered to the return to accomplish the desired results, the blow-over connection is resealed and remains so until there is need for an additional supply of steam.

When the Loop functions it maintains a fixed differential pressure between the steam and return main. In the standard No. 0 and No. 02 Loops the differential pressure is 10 ounces, while with the No. 03 and No. 04 a 14-ounce differential is maintained. The maintenance of this differential permits circulation of steam throughout the system even though the main vent port is closed. Furthermore, by the maintenance of this differential when the Loop has functioned, a radiator which has been turned off may be put into commission and filled with steam in practically the same time as would be required if the Loop had not functioned.

Hoffman No. 15 Valve

In conjunction with the Loop a special valve for venting the entire system is used—the No. 15 Hoffman Vacuum Valve—which permits free venting of air through its ¾-inch vent port and prevents air returning to the system by means of a light check, which is thoroughly reliable in fulfilling its requirements.

The No. 15 Valve is intended for use only in connection with Hoffman Differential Loops.

No. 14A Hoffman Kompo-Gage

THE Hoffman Kompo Gage is used with either Hoffman Controlled Heat installations or One Pipe Gravity Systems equipped with No. 2 Vacuum Valves. It accurately indicates the conditions under which the plant is operating.

The Kompo Gage measures pressure up to 30 lbs., the first 5 lbs. shown in ounce graduations, with a retard from 5 to 30 lbs. Vacuum is shown up to 30 inches, the first 10 inches in ½ in. graduations and retarded from 10 to 30 inches. An externally operated set screw resets the hand to zero if jarred from its normal position during shipment.

Diameter 5 inches, Connection ¼ in.

Hoffman Specialties

For convenience in estimating and ordering Hoffman Controlled Heat Equipment is grouped into 2 classes.

Radiator Specialties consisting of

1 No. 7 Hoffman Modulating Valve

1 No. 8 Hoffman Return Line Valve

Basement Specialties, consisting of the following classes are grouped according to size of installation.

Hoffman Specialties—Group Assortments

For Single Boiler Installations

CLASS "O"

Basement Specialties for installations up to 2000 sq. ft. Direct Radiation, consisting of

2	No. 18	Return Line Valves for venting Steam Mains into Dry Return.
1	No. 0	Hoffman Differential Loop, including one No. 15 Vacuum Valve.
1	No. 13	Hoffman Damper Regulator.
1	No. 14A	Hoffman Kompo Gage.

CLASS "B"

Basement Specialties for installations of 2001 to 3500 sq. ft. Direct Radiation, consisting of

3	No. 18	Return Line Valves for Venting Steam Mains into Dry Return.
1	No. 02	Hoffman Differential Loop, including one No. 15 Vacuum Valve.
1	No. 13	Hoffman Damper Regulator.
1	No. 14A	Hoffman Kompo Gage.

Hoffman Specialties Group Assortments (continued)

CLASS "C"

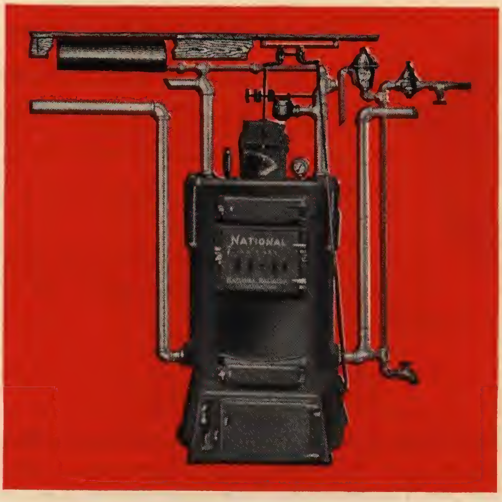
Basement Specialties for installations of 3501 to 7500 sq. ft. Direct Radiation, consisting of

4 No. 18	Return Line Valves for venting Steam Mains into Dry Return.
1 No. 03	Hoffman Differential Loop, including one No. 15 Vacuum Valve.
1 No. 13	Hoffman Damper Regulator.
1 No. 14A	Hoffman Kompo Gage.

CLASS "D"

Basement Specialties for installations of 7501 to 15,000 sq. ft. Direct Radiation, consisting of

6 No. 18	Return Line Valves for venting Steam Mains into Dry Return.
1 No. 04	Hoffman Differential Loop, including two No. 15 Vacuum Valves.
1 No. 13	Hoffman Damper Regulator.
1 No. 14A	Hoffman Kompo Gage.



Thrush System of Hot Water Heating

The Thrush System for regulating hot water heating plants not only provides Automatic Temperature Damper Regulation, but it makes of any gravity job a Closed System operating under increased pressure with increased heat transmission and greater fuel economy resulting.

Patented Thrush Pressure Relief Valve

Thrush Water Relief

The Thrush Differential Pressure Relief Valve provides a safe overflow and holds a constant pressure against air cushion in pressure tank. The Differential principle builds up pressure tending to open the valve, nearly ten times as great as the pressure in the system, assuring positive operation. The valve seat is submerged in water so there is no place for corrosion or sediment to accumulate.

Thrush Pressure Reducing Valve

FURNISHED with Thrush Class Double (AA) equipment and Double (BB) equipment to maintain constant pressures from water lines and to provide automatic refilling of boiler. First quality construction, brass working parts, submerged valve seat, non-corrosive parts. Adjustment easily made for various pressures without special tool.

Thrush Regulator

THE Thrush Thermostatic Temper Damper Regulator consists of a 3″ Multiple Disc Thermostat which sets in an inner shell surrounded with the hot water from the boiler. The Thermostats operate the lever with the change of the water temperature, thus maintaining uniform temperatures in the rooms to be heated. This also prevents runaway fires and saves fuel. Regulator is complete within itself and can be adapted to any kind of Hot Water Boiler. Requires very little attention for proper operation. Thrush System comes complete with full instructions for operation. Installation is easy as it all goes on or near the boiler and requires only six feet of pipe and eight connections. Thrush Piping Plans free to the trade.

Thrush Group Assortments

Thrush Class Double (AA) Equipment

Automatic Filling, consists of Thrush Automatic Damper Regulator, Differential Pressure Relief, Pressure Reducing Valve, Copper Bearing Steel Tank and Special Gauge.

Size No. 0 up to 350 sq. ft. of radiation.
Size No. 1 up to 700 sq. ft. of radiation.
Size No. 2 up to 1200 sq. ft. of radiation.
Size No. 3 up to 2000 sq. ft. of radiation.

Thrush Class A Equipment

Same as above except it has no Pressure Reducing Valve for Automatic Filling.

Size No. 0 up to 350 sq. ft. of radiation.
Size No. 1 up to 700 sq. ft. of radiation.
Size No. 2 up to 1200 sq. ft. of radiation.
Size No. 3 up to 2000 sq. ft. of radiation.

Thrush Class Double (BB) Equipment

Automatic Filling, consists of Thrush Differential Pressure Relief, Pressure Reducing Valve, Copper Bearing Steel Pressure Tank and Special Gauge.

Thrush Group Assortments (continued)

Size No. 0	up to	350	sq. ft. of radiation.
Size No. 1	up to	700	sq. ft. of radiation.
Size No. 2	up to	1200	sq. ft. of radiation.
Size No. 3	up to	2000	sq. ft. of radiation.

Thrush Class B Equipment

Same as above except it does not have Reducing Pressure Valve for Automatic Filling.

Size No. 0	up to	350	sq. ft. of radiation.
Size No. 1	up to	700	sq. ft. of radiation.
Size No. 2	up to	1200	sq. ft. of radiation.
Size No. 3	up to	2000	sq. ft. of radiation.

Thrush Separate Units

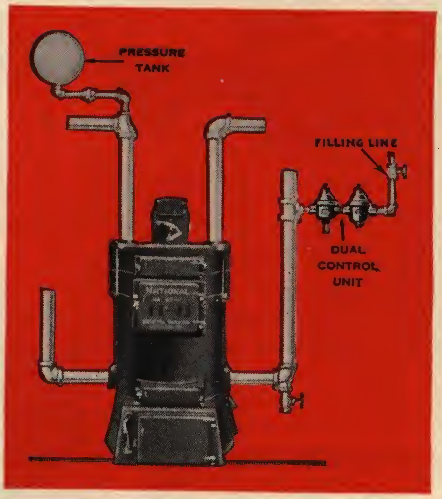
Thrush Automatic Damper Regulator.
Thrush Differential Pressure Relief.

Thrush Copper Bearing Steel Pressure Tanks

Size No. 0	up to	350	sq. ft. of radiation.
Size No. 1	up to	700	sq. ft. of radiation.
Size No. 2	up to	1200	sq. ft. of radiation.
Size No. 3	up to	2000	sq. ft. of radiation.

NOTE: For Buildings Higher than 3 Stories, Use One Size Larger Pressure Tank.

The Thrush Dual Control Unit



For Hot Water Heating

THE Automatic Dual Control Unit may be used for small to medium sized hot water heating plants, easily and economically, by merely installing the Dual Control Unit in the water supply line. This provides the advantages of a pressure or "closed system" with increased circulation and heating efficiency and assures safety to the equipment. The water supply is maintained automatically and excessive pressures are automatically relieved.

Installation is very simple, easy and inexpensive. Requires no attention or effort on the customer's part. For greatest efficiency a pressure tank should be added.

The Dual Control Unit

Soundly engineered, dependably built. Guaranteed against defects in material and workmanship.

Dual Control Pressure Reducing Valve

A high grade, thoroughly dependable device. Working parts are made of high quality brass. Pressure may be changed or varied to suit local conditions as they exist on the job. These Pressure Reducing Valves are set at the factory to maintain pressure from 12 to 15 pounds, suitable for a two or three-story building.

Dual Control Water Relief Valve

An efficient safety device. It is very dependable, having no small restricted openings, no tight-fitting working parts. Working parts are brass throughout and non-corrosive. Pressure is adjustable within a slight range, but cannot be set to more than 35 pounds pressure. Guaranteed against defects of material and workmanship. A good valve for small jobs.

Galvanized Expansion Tanks

These tanks are made of refined galvanized steel, and are double riveted, caulked and tested to 100 pounds pressure. They are tapped top and bottom for one-inch overflow, and expansion pipe, and on the side near the top 1-inch for filling attachment. Also tapped for ½-inch water gauge brasses on 12-inch centers. Furnished in 8, 10, 15, 20, 26, 32 and 42 gallon capacities.

Sure Grip Tank Bracket

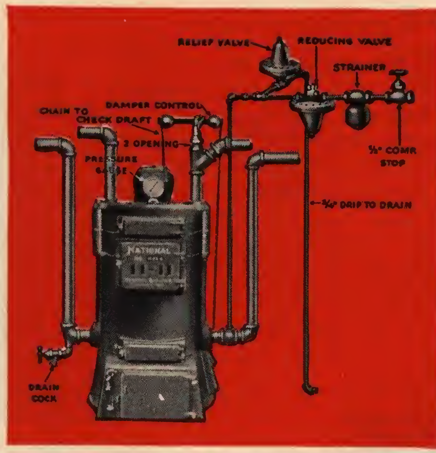
Fits any size tank. Heavy castings, with adequate strength to support full tanks. Easily applied with heavy screws.

Pop Safety Valves

Made to A. S. M. E. standards. Spring will retain resiliency indefinitely. Valve and seat non-corrosive, non-sticking. Fitted with a hand release lever. Set at factory to 15 pounds and sealed.

The heavy hex nut on the base permits wrench to be used in installation without crushing seat or housing.

Size	¾″	1″	1¼″	1½″	2″	2½″	3″	3½″	4″

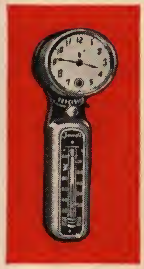


Mueller System of Hot Water Heat Control

THE Mueller System provides a means of converting a gravity return system into a closed system, with a consequent increase in the speed of circulation, and so of the heating effectiveness of the installation. All equipment is on one assembly, and so can be quickly and economically installed.

The expansion tank is eliminated completely, the necessary pressure head being built up by the expansion of the water in the closed system. Any water lost from system is replaced through the reducing valve, when the pressure drops to the point at which it is set.

The assembly complete consists of a relief valve, a reducing valve, a strainer, and a ½-inch compression stop. In addition a damper control and pressure gauge, not on assembly, are furnished.



Jewell Temperature Regulators

FOR most satisfactory operation, 3-unit controls—Room Thermostat, Limiting Device, and Motor—are recommended.

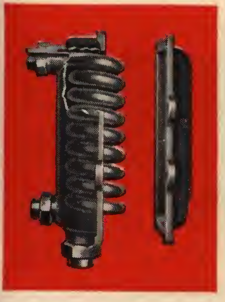
The Jewell Thermostatic Unit has a bimetallic coil that is extremely sensitive to heat and cold. One degree change in temperature above or below normal level makes this coil expand or contract. This makes an electric contact which causes the motor in the basement to operate, and open or close the draft and check dampers on the boiler. An adjustable indicator is provided, so that this operation will take place at any desired temperature. The clock thermostats automatically open the drafts at any pre-determined time in the morning, and bring the house up to the desired temperature. The eight day clock thermostat, in addition to this, shuts the drafts and checks the fire at a pre-determined time in the evening.

To specify a complete regulator by written or telegraphic code give the model number of the units wanted. For example, an order for the units mentioned above would read, "One J-8, A-1, J-E Regulator." This is important and necessary to insure the packing of the required fittings for the installation of the equipment.

Jewell Regulator Units

Item	Model Number	Description
Thermostats	J-8	Eight-Day Clock Thermostat
	J-1	One-Day Clock Thermostat
	J-0	Plain Thermostat
Limiting Devices	B-2	Immersion Aquastat for Hot Water
	70	Pressure Regulator—for Steam
	A-1	Vaportrol for Low Pressure Vapor
	E-1	Surface Aquastat
Motors	J-E-S	Electric 110V. 60 Cy. A. C. with built-in switch
	J-E	Electric 110V. 60 Cy. A. C.
	J-S	Spring Motor
	J-G	Gravity Motor

Upon special order motors can be furnished in 110 or 220 volt, 25, 30, 40 or 50 cycle A. C. and 110 or 220 Volt D. C.



Taco Heaters

Domestic Taco with Brass Unions

THE Domestic Taco Water Heater is connected below the water line of steam or vapor boilers. The water in the heating boiler circulates through shell of Taco, transferring its heat to the domestic water which flows through the coil to the tank. The Domestic Taco Heater consists of a cast iron housing containing a one-piece coil to which it is permanently fastened and tested to 1,200 pounds making positive assurance against leakage. Unions are provided for quick installation. Water is in contact with copper and brass (not iron) to avoid any possible discoloration. Removable cover permits of easy cleaning without disconnecting any piping. Sizes No. 0, 30, 1, 2 and 3. See Super Taco for larger capacities.

Size	0	30	1	1A	2	2A	3
Capacity, below water line, gal. 100° rise 3 hours	30	30–40	40–60	60–80	80–120	120–160	160–200
100° rise 1 hour	.....	.....	.....	.....	30–40	40–50	50–66
Square feet water radiation	.....	.....	.....	.....	60	90	120
Height, inches	8½	11	13	14	16½	19	21½
Diameter, inches	5½	5½	5½	7	7½	8½	8½
Tank connections, inches	¾	¾	¾	1	1	1	1¼
Boiler connections, inches	1	1	1	1¼	1¼	1½	2
Shipping weight, pounds	9	11	14	20	24	45	54

Taco Apartment Heaters

THE Apartment Taco is designed primarily for use with live steam wherever constant steam supply is available, as from a central plant. Used for heating domestic water or heating hot water radiators. Can also be used below water line of steam heating boilers. Apartment Taco is installed in a horizontal position—consists of cast iron housing containing a series of copper "U" tubes through which the domestic water circulates. Double top and bottom connections in shell regularly furnished for use when heating hot water radiators, or otherwise when required.

Taco No. 4, 5, 6

Size	4	5	6
Capacity, below water line, gal.	*	*	*
Cap. Steam Gals. 100° rise 3 hrs.	600	1200	1800
**Cap. Steam Gals. 100° rise 1 hr.	200	400	600
Square feet water radiation	240	480	750
Length, inches	26	38	40
Diameter, inches	8	11¾	13½
Tank connections, inches	2	2½	3
Boiler connections, inches	2	2½	3
Shipping weight, pounds	96	192	265

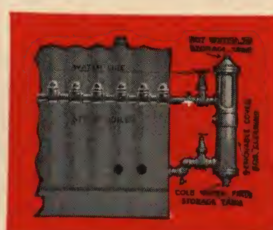
*For these capacities Super Tacos are recommended.
When desired below water line, Capacity Gallons.
100° rise 3 hrs. No. 4, 320; No. 5, 640; No. 6, 960
**100° rise 1 hr. No. 4, 100; No. 5, 210; No. 6, 320

Super Taco Heaters

SUPER TACO—A Vertical Type Heater for Installation Either Entirely Below, or Partly Below and Partly Above Water Line of Steam and Vapor Heating Boilers.

Capacities from 160 to 5000 gal. The Super Taco is a vertical type water heater made in a wide range of sizes. Consists of a cast iron housing to which water and steam from the heating boiler is admitted, transmitting heat through a series of vertical copper tubes to domestic water circulating to storage tank. Heads are of heavy bronze on all sizes up to and including No. 50. Liberal pipe connections provided. Vertically installed so as to provide positive circulation to hot water tank, even when located relatively low. Removable cover provides for easy cleaning without disconnecting any piping.

Where Oil Is Used for Fuel—When Taco Heaters are to be used in conjunction with a boiler using an automatic oil burner it will be necessary to increase the size of the Taco Heater, approximately, three times. For instance, where with coal a 200-gal. tank requires a No. 8 Taco Heater which has a capacity of 220 gal., a No. 12 Taco Heater which has a capacity of 600 gal. would be required when oil-fired. This is due to intermittent operation of oil burner and lower average temperature of boiler water.



Super Taco Heaters

SUPER-TACOS are furnished with or without jackets. Jackets are of heavy steel, finished with two coats of baked red enamel with black trimmings, and are thoroughly insulated with Asbestocel.

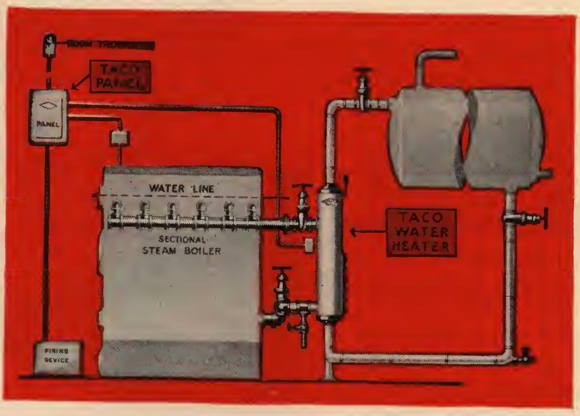
Super Tacos are equipped with removable bronze heads for tank connections. 4 convenient tappings for boiler connections. Vertical copper tubing assures quick heating.

Size	7	8	9	10	12	15	20	25	35	50	75	100
Capacity, gal.....												
100° rise 3 hrs...	160	220	320	450	600	800	1000	1250	1750	2500	3750	5000
**100° rise 1 hr....	52	70	100	150	200	265	333	415	580	830	1250	1660
A (inches)........	8	10	8	10	10	12	7½	8½	8½	12	12	12
B (inches)........	5½	7½	5	7	6½	9	8	11½	11½	18	18	18
C (inches)........	13½	17½	13	17	16½	21	15½	20	20	30	30	29
D (inches)........	3¾	3¾	5	5	6	6	7	7	7½	8½	10½	12½
E (inches)........	6¼	6¼	7½	7½	9¼	9¼	11¾	11¾	14¼	14¼	19	21
F (inches)........	34½	42½	36	44	45	54	45	54	55	77	81	84
Boiler Con's., in...	2	2	2½	2½	3	3	4	4	4	5	5	6
Tank Con's., in....	1½	1½	2	2	2	2	2½	2½	4	4	5	6
Shipping wt., lbs...	70	100	130	150	185	220	280	350	500	685	1050	1250

Increase size of Taco for inadequate tank capacity. Thirty-gallon tank capacity is usually required per family.

**For intermittent oil or gas fired installations, capacities based on 100° temperature rise in 1 hour are recommended.

Taco Heaters



Taco-Abbott System
For Oil Burner Installations

THE Taco-Abbott System (patented) is designed for furnishing year-round domestic hot water, using a steam heating boiler with an intermittent firing device and full automatic control.

The illustration shows a cast iron sectional boiler having each section tapped and headed together just below the water line. This permits a free circulation of the boiler water to the Taco from all sections of the boiler and prevents the boiler from steaming during the summer months. With round cast iron and steel boilers no header is needed. The boiler water temperature control is attached to the super TACO, a tapping for this being provided. This control is set to maintain a given water temperature in the boiler continuously, usually 170° to 180° F. The connecting of the room thermostat, together with the other controls, to the proper posts in the TACO

Taco Abbott Systems (continued)

Panel, prevents the boiler from making steam unless the room thermostat is demanding heat, hence there is no steam in the radiators during the summer months or on warm winter days.

Universal Taco

For use in any round hot water heating boiler. Better than a pipe coil. Fits in the fire pot. Interferes less with fire and there are no screwed connections to burn out. Three 1-in. connections on back, one on bottom. Made in both brass and malleable iron.

No.	Capacity Gallons	Height Inches	Width Inches	Shipping Weight Lbs.
6-9-30 Iron	30	$10\frac{1}{2}$	6	10
6-9-60 Iron	60	$10\frac{1}{2}$	$11\frac{1}{2}$	17
6-9-30 Brass	30	$10\frac{1}{2}$	6	10
6-9-60 Brass	60	$10\frac{1}{2}$	$11\frac{1}{2}$	17

Rotary Hack Saw Tool

For Tapping Cast Iron and Steel Boilers. Cuts openings 1", $1\frac{1}{4}$", $1\frac{1}{2}$", and 2" leaving exact amount of stock for pipe threads.

Tool furnished complete including two blades of every size.

Naraco Water Regulator

No. 800A

Patented Sept. 23, 1924. Patent Pending

For Damper Control on Hot Water Boiler

A DAMPER regulator designed for hot water boilers which will control the drafts so as to maintain a constant water temperature at any degree between 100° and 220° Fahrenheit.

The Naraco Water Regulator is made entirely of metal. Within the bulb is an expansion metallic bellows, surrounding which is volatile liquid. As the water temperature in the system increases, the liquid vaporizes and the gas pressure generated thereby compresses the bellows and forces upward the thrust rod or stem which tilts the lever and closes the drafts. As the water cools the gas pressure is relieved and the counterweight opens the drafts. There are no perishable parts to wear out. The action is sensitive and accurate. Adjustment for temperature is obtained by changing the position of weights on the lever.

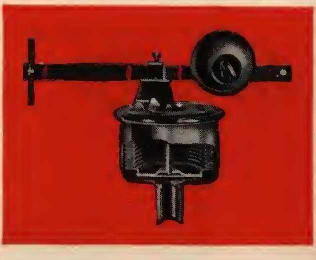
Data and Dimensions

Length of bulb, 2⅞ inches. Connection, 2-inch standard pipe thread. Trimmings consist of one 37-inch lever, two four-pound weights, 12 feet of chain, two ceiling pulleys, four "S" Hooks. Shipping weight, 15 pounds.

Naraco Steam Regulator

No. 905A

Patent Pending



An improved type of all metal pressure regulator for controlling dampers on steam heating boilers. Extreme sensitiveness has been obtained by a new design of rocker. The operating element is a one piece brass metallic bellows—not built up from discs. The head is an integral part of the bellows, which eliminates the possibilities of leakage at soldered joints.

For steam pressure up to 15 pounds—finely finished in black baked-on enamel. Connection to boiler 1-inch I. P. S. male thread. Trimmings furnished, one 36-inch lever, one 4-pound weight, 12 feet of chain, two ceiling pulleys, four S-Hooks. Shipping weight 16 pounds.

Naraco Junior Water Regulator No. 801A

Patented Sept. 23, 1924 Pending

This regulator is designed especially for hot water supply boilers. The construction and operation is similar to that of No. 800 A Water Regulator, described on page 275, but it is smaller and less powerful.

The Naraco Junior Water Regulator saves fuel by preventing overheating, saves attention to drafts, maintains constant water temperature, prevents boiling, sputtering, steaming water at the faucets and insures plenty of hot water as long as there is sufficient fire in the heater.

Data and Dimensions

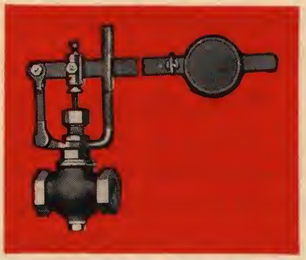
Length of bulb, 2 inches. Connection 1½ inch standard pipe thread. Temperature Range, 130° to 180° Fahr. Trimmings furnished, one 30-inch lever, one 3-lb. weight, 6 feet of chain, two "S" hooks. Shipping weight, 11 pounds.

McDonnell & Miller Duplex Boiler Feeder

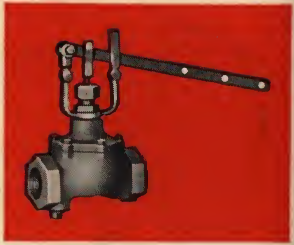
THIS feeder maintains the water line at all times and under all conditions of service, supplying the feed water requirements automatically and removing excess water when the boiler water line is abnormally high. Highly desirable for steam systems, and especially important on oil-burning installations. Has self-cleaning rotary phosphor bronze valves, with monel metal seats, insulated from float chamber, to prevent formation of scale. Rectangular valve orifices, and stream line water passages, reduce flow resistance to a minimum; and so supply water has full city pressure behind it. Water line may be changed over a range of two inches after installation, and differential changed to 1, 2, 3, 4, or 5 inches.

For Small Boilers

To meet the demand for a small water feeder, suitable for residence use, the No. 30 McDonnell and Miller Safety Feeder has been developed. This feeder is amazingly simple, positive in action, and highly effective. It is equipped with stainless steel valves, which eliminate the possibility of sticking. All of the quality features of the larger model have been retained.



For use on natural gas



For use on central plant steam or gas

National Regulating Valves

Well made, sensitive, and positive acting. Adjustable weight. By-pass connection for pilot light.

Sizes	1″	1¼″	1½″	2″

Empire Steam Traps

These traps as regularly made, are for low pressure, and should not be used where pressures exceed 20 pounds per square inch.

The copper floats are of the finest material, and are guaranteed not to collapse at authorized working pressures. The valve stems operate through guides, eliminating any possibility of their being unseated.

Sizes and Capacities

Number	00	0	1	2	3
Weight, Pounds	15	30	59	72	117
Inlet connections, inches	¾	1	1¼	1½	2
Outlet connection, inches	¾	¾	1	1¼	1½
Drainage capacity, lineal feet of 1-inch pipe	9,000	15,000	36,000	54,000	80,000
Drainage capacity, square feet of direct radiating surface	3,000	5,000	12,000	18,000	27,000

The above capacities are based on a condensation equal to 33/100-pound of water per hour per square foot of radiation, operating under low pressure.

Arrow Hot Water Storage Tanks

ALL pressure tanks are built of best grade of open hearth steel sheets and plates. Longitudinal seams are riveted and electrically welded. Heads are dished, and shell is flanged over it, and welded. Each tank is tested to pressure 50% greater than working pressure shown. Furnished with black finish, or galvanized.

STANDARD Tested to 100 lbs. and guaranteed for 65 lbs. working pressure.				EXTRA HEAVY Tested to 150 lbs. and guaranteed for 100 lbs. working pressure.	
Capacity Gals.	Size In.—Ft.	Approximate Wt.	Size Openings	Approximate Wt.	Size Openings
82	20 x 5	215	1½″	300	1½″
118	24 x 5	285	1½″	375	1½″
141	24 x 6	325	1½″	425	1½″
183	30 x 5	510	2″	550	2″
220	30 x 6	575	2″	610	2″
250	30 x 7	690	2″	725	2″
294	30 x 8	710	2″	750	2″
318	36 x 6	725	2″	950	2″
423	36 x 8	875	2″	1250	2″
504	42 x 7	1125	2″	1400	2″
576	42 x 8	1175	2″	1550	2″
720	42 x 10	1350	2″	1700	2″
1008	42 x 14	1825	2″	2300	2″
940	48 x 10	1900	3″	2000	3″
1128	48 x 12	2200	3″	2300	3″
1316	48 x 14	2600	3″	2700	3″
1504	48 x 16	2900	3″	3000	3″
1880	48 x 20	3425	3″	3550	3″
1480	54 x 12	2750	3″	3300	3″
1600	54 x 13	2900	3″	3500	3″
1720	54 x 14	3050	3″	3700	3″
2130	60 x 14	3650	3″	4200	3″
2275	60 x 15	3825	3″	4225	3″
2425	60 x 16	4000	3″	4650	3″
2625	60 x 17′ 6″	4275	3″	4950	3″

Arrow Manholes, Handholes and Flanged Openings

MANHOLE in shell adds to weight of tank 150 lbs. —in Head 100 lbs.

If manholes are ordered in tanks of diameters 48″ and less, they will be placed in the head unless otherwise specified.

Handhole can be placed in head or shell of any tank. Standard manhole can be placed in shell of any 36″ or larger diameter tank, or in head of any 20″ or larger diameter tank.

Orders for tanks with coils, manholes, handholes, and special openings are special and not subject to cancellation after work has been started. Change in size of openings to those shown below can be made at additional cost.

Flanges 2″ or 2½″, 3″ or 3½″, 4″

Spuds 2″, 2½″, 3″, 3½″, 4″

Handhole (4″ x 6″) in head or shell—Manhole (11″ x 15″) in head
Manhole (11″ x 15″) in shell

Coils for Storage Tanks

Inlet and Outlet pipes enter tank through couplings which are securely welded to the tank head.

Coils listed below are of four pipe return bend type for horizontal installation furnished in galvanized, black, copper or brass. Spiral coils for vertical installation quoted on application.

Tank Size In.—Ft.	*Coil Size*	*Tank Size In.—Ft.*	*Coil Size*	*Tank Size In.—Ft.*	*Coil Size*
20 x 5	1″	36 x 8	1½″	48 x 20	2″
24 x 5	1¼″	42 x 7	1½″	54 x 12	2″
24 x 6	1¼″	42 x 8	1½″	54 x 13	2″
30 x 5	1¼″	42 x 10	1½″	54 x 14	2″
30 x 6	1¼″	42 x 14	1½″	60 x 14	2″
30 x 7	1¼″	48 x 10	2″	60 x 15	2″
30 x 8	1¼″	48 x 12	2″	60 x 16	2″
36 x 6	1½″	48 x 14	2″	60 x 17′ 6″	2″
		48 x 16	2″		

National Floor and Ceiling Plates

These plates are made of cold rolled steel, heavily coppered and nickel plated. Springs are strong and resilient, and will not lose their temper under steam temperatures. Plates may be used for either floor or ceiling work, and are hinged, so they may be applied at completion of job.

Size, inches	½	¾	1	1¼	1½	2	2½	3	3½	4

National Hot Water Thermometers

Accurate temperature recorders, each individually calibrated in factory before shipment. Bulb rests in mercury bath. Ranges from 60° to 260°. A small set screw permits the removal of the tube without taking out the well, which would necessitate draining system. Threaded for ½-inch tapping. National Hot Water Thermometers can also be furnished in angle pattern upon request.

National Steam Gauge

This gauge is finely made, and accurately calibrated. Has oven baked white enamel case. Operates on the Bourdon-tube principle. Has siphon, to clear tube of condensate, and non-glare dial, with large, legible graduations. Registers by pounds 0 to 30 limits. Sizes 3½″ and 4½″. Larger sizes, up to 6″, may be secured on special order.

National Altitude Gauge

This gauge accurately records height of water from 0 to 70 ft. by feet, in hot water system. Provided with dial reading in pounds for use with closed systems. Has oven baked white enamel case. Operates on Bourdon-tube principle; has red master hand, which is set to column height to be maintained, and assures accurate filling of system.

These gauges can also be furnished graduated for both altitude and water pressure in pounds, for use on either open or closed systems. Legible figures, non-glare dial. Sizes 3½″ and 4½″.

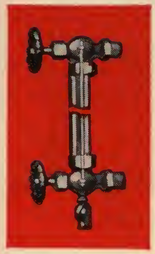
Larger sizes, up to 6″, may be secured on special order.

National Low Pressure Retard Gauge

Has all good features of standard steam gauge, and in addition reads by ounces up to 10 pounds pressure, and by 5 pounds graduations from this point up to 30 pounds. Highly accurate, and gives exact knowledge of the pressure within the boiler. Oven baked white enamel dial and case. Furnished regularly in 3½″ or 4½″ sizes. Larger sizes, up to 6″, may be secured on special order.

National Compound Gauge

Not only reads pressures, but vacuum. Graduations to right of top center of dial are in ounces up to 5 pounds, then 5-pound graduation up to 30 pounds. Graduations to left of top center are in inches of vacuum, by ½-inch graduations up to 10 inches. Has oven baked white enamel dial and case. Furnished regularly in 3½″ and 4½″ sizes. Larger sizes, up to 6″, may be secured on special order.



No. 335 National Brass Expansion Tank Water Gauges

These gauges are self-cleaning. They are low pressure equipped with iron hand wheels to cut off water when replacing glass. There is a cock at bottom to drain off sediment, and to check glass. Equipped with two guards. Every expansion tank should be fitted with a gauge. Furnished in ½″ size with 12″ glass and ¾″ size with 16″ glass.

No. 425 National Draw-Off Cocks

Sturdy and well made, with hand wheel valve. Discharge is threaded so hose may be attached. Removable washer. Sizes ½″ and ¾″.

National Novus Spud Wrench

This is an exceptionally durable tool, that should be in every fitter's kit. Graduated sizes, to fit 2, 1½, 1¼, 1 and ¾ spuds.

Pin Handle Socket Wrench

Another tool without which no fitter's kit is complete, for tightening nuts on radiator rods. Made of forged steel, finely finished, and is strong and durable. Tapered on the outside, to allow wrench to be inserted between columns. Size ⅜″ or ½″.

Screw Nipple Radiator Wrenches

Made with machined end, to fit radiator screw nipples with 2 lugs on inside.

Radiator Cleaning Brushes

These brushes were especially designed to clean dust from the interior portions of radiators, ordinarily difficult to reach. The stiff bristles are held on a wire shaft, firmly secured in a wooden handle.

No. 7

National Novus Boiler Brushes

Soot may decrease the efficiency of a boiler as much as 25%—a potent argument for frequent cleaning with Novus brushes. Strong, springy, wire bristles, that last out the season, firmly secured on a threaded shank. This shank will fit any standard flue-brush handle.

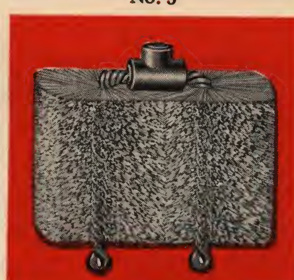
Dimensions

Number	Shape	Width	Breadth
3	oval	4″	2″
7	double	4″	1¾″
8	"	6″	2½″

National Bronze Brush

High Grade, with Fitch bristles, firmly held to prevent shedding. For applying bronze finishes to radiators.

No. 3



No. 8

National Bronze

A HIGH grade bronze, furnished in Aluminum, Antique copper, light green, mahogany, chestnut, walnut, and oak finishes. The quality of bronze is not dependent on the nature of the material, but on the fineness of the pulverizing. National Aluminum is ground very fine, while the brass is pulverized by pounding it through a screen, the process taking from 12 to 14 hours. The resulting flakes are polished, resulting in a thin, brilliant coating, over which the liquid will flow, keeping it permanently bright. The table below shows the amounts of bronze, and bronzing liquid (furnished in gallon and half-gallon patent stoppered cans) required for a given amount of radiation.

Type	Bronze	Liquid	Rad. Covered
Gold "X"	3¾ lb.	1-gal.	1100 sq. ft.
Gold "XX"	3 lb.	1-gal.	1250 sq. ft.
Aluminum "XX"	1½ lb.	1-gal.	1100 sq. ft.

Novus Black Asphaltum

Before an installation is considered completed, all exposed piping in the cellar should be given a coat or two of black asphaltum, to add a finishing touch. Will not crack or flake off. It insulates, protects, and beautifies.

National Solder Seal

A scientifically prepared material that, placed in the boiler, will search out any leaks in the system and seal them. Solidifies only when exposed to air; material in system remains in suspension, and circulates with water. One can (1 pound) recommended for 1750 feet of radiation.

Boiler Se-Ment-Ol

Used for the same purpose as is Solder-Seal, but it is in a liquid form. One can (one quart) should be used for each 150 to 250 feet of radiation.

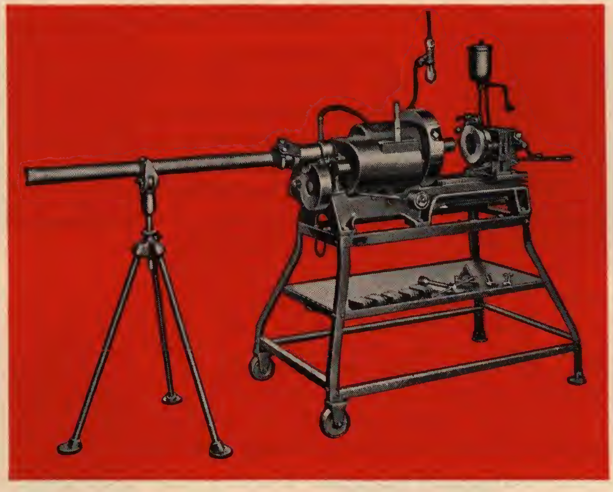
Vinco Cleaner

More than 75 per cent of ordinary domestic heating troubles come from dirty boilers. Dirt and oil decrease efficiency, and cut down heat furnished. Vinco cleaner is guaranteed to put the system back in first-class shape, and correct foaming, surging, priming and slow steaming. Ask for free laboratory service on feed water analysis. Vinco is packed in 1½, 3, 5, and 10 pound cans.

Quantity of Vinco Required for the First Clean-Out*

Up to	350	sq.	ft.	of	radiation	3	lb.
351 "	600	"	"	"	"	5	"
601 "	1100	"	"	"	"	8	"
1101 "	1400	"	"	"	"	10	"
1401 "	1800	"	"	"	"	13	"
1801 "	2100	"	"	"	"	15	"
2101 "	2700	"	"	"	"	18	"
2701 "	3100	"	"	"	"	20	"
3101 "	3700	"	"	"	"	23	"
3701 "	4200	"	"	"	"	26	"
4201 "	4600	"	"	"	"	28	"
4601 "	5000	"	"	"	"	30	"

*Hot Water Systems and Old Systems need half these quantities.



Rogaco Portable Electric Pipe Machines

THE Rogaco Portable Electric Pipe Machine is designed for cutting off, reaming, threading and making on fittings. It is suitable as a bolt, bar or pipe machine. The bar or pipe is held in the universal chuck, and is centered at the rear end of the spindle by a special centering device. The pipe at the cut-off tool is centered by hardened V jaws. This gives three centering points. The machine cuts threads which are straight and true to gauge.

It is equipped with a gear shift which gives two right hand spindle speeds and two left hand. A vertical lever controls the speed changes. A horizontal lever operating on the side controls the direction in which spindle revolves.

The standard equipment of the Rogaco Pipe Machine includes a special motor, enclosed in a dirt and grease-proof case, single and double engineer's wrenches, electric

cable with lamp socket connections, and a full set of right-hand dies 3/8 to 2 inches, or a Rogaco quick opening die complete with chasers 1/2 to 2 inches, whichever is desired.

All controls are within easy reach of the operator. The motor can be started or stopped instantly by turning a snap switch. The carriage is controlled by a lever operating through a rack and pinion. There are special cut-outs on the carriage which throw it out of mesh automatically.

This machine will thread pieces of pipe as short as 3 1/2 inches end to end. Close nipples or thread to thread nipples can be cut by use of the Rogaco nipple chuck, which is furnished as an accessory when desired.

With the Rogaco reversible power drive attachment and hand geared stocks, such as Beaver or Toledo, the capacity of the machine can be increased to 8 inches in diameter, or even up to 12 inches. With this attachment it is not necessary to back off by hand; the machine is reversed and it backs off by power.

Description	Approx. Shipping Wt., Lbs.
Machine Complete with Right-Hand Solid Dies 3/8 to 2-Inch, or Rogaco Quick Opening Die with Chasers 1/2 to 2-Inch, and Either an A. C. or D. C. Motor of Standard Current Characteristics	600
Angle Iron Truck Stand	100
Rogaco Reversible Power Drive	30
Roller Bearing Tripod Pipe Support	30
Rogaco Nipple Chuck with Bushings 3/8 to 2-Inch	20
Extra Motor, Either A. C. or D. C.	100
Extra Sets of Chasers for Opening Die Sizes 1/2 to 2-Inch, Six Sets, Four Chasers to a Set, per set	1
Extra Solid Dies, Sizes 3/8 to 2-Inch, Seven Dies, per set	14
Extra Bushings for Nipple Chuck, 3/8 to 2-Inch, Seven Sizes per set	1
Rogaco Quick Opening Die Complete with Chasers 1/2 to 2-Inch	38

NATIONAL ENGINEERING DATA

Compiled by

SAMUEL E. DIBBLE

Past President American Society of Heating and Ventilating Engineers; Professor and Head of the Heating and Ventilating Department of Carnegie Institute of Technology.

INDEX

INDEX (continued)

FOREWORD

THE purpose of National Engineering Data is to provide facilities for ready reference in connection with problems having to do with the installation of National *Made-to-Measure* Heating Systems. By descriptive text, charts, tables, diagrams, etc., pertinent information is cataloged and made available to National Heating Specialists to enable them to install a modern heating system of exact specifications in such a manner that they can stand unqualifiedly in back of the job. No attempt has been made to incorporate tables dealing with matters largely of an academic nature as these same tables are available in various government books, text books and hand books. However, a very sincere

attempt has been made to handle the problems of correct boiler type and style, correct radiation type and size, and correct technique in combining them to give the customer meritorious results. Thus the heating contractor may win new friends and secure an ever-increasing volume of business because of the high quality of his work and the happiness and contentment his customers enjoy from their National *Made-to-Measure* Heating Systems.

Acknowledgement is gratefully made to the American Society of Heating and Ventilating Engineers, and the Heating and Piping Contractor's National Association for research and engineering data referred to or used.

Points a Heating Contractor Should Recommend

ALL too often the heating plant is blamed for failure to properly warm a building, when the fault is entirely due to incorrect building construction. While this is not primarily the business of the heating contractor, he can do effective missionary work for better construction. Economies resulting from such construction will build good-will for him.

It is suggested, therefore, that heating contractors make the following recommendations:

(1) Provide chimney of proper dimensions; tile lined to prevent leakage.

A good chimney is essential to proper combustion and satisfactory plant operation.

(2) Cover boiler and piping with insulation.

This saves fuel by reducing heat loss and also greatly improves the appearance of the installation.

(3) Install a room thermostat.

It saves labor by automatically regulating the drafts, maintains uniform room temperature, and builds good will.

(4) Weatherstrip doors and windows, and install storm sash and doors.

This saves sufficient fuel to justify its being strongly urged.

(5) Insulate walls and roofs.

This cuts down heat losses, saves fuel, makes a more comfortable home in summer as well as in winter.

Determining Radiation Requirements

THE first step in planning a heating system is the determination of the correct amount of radiation required to properly heat each individual room. In order to do this it is necessary to compute the heat loss through walls, glass, etc., and the loss due to infiltration. This involves many calculations and is perhaps one of the reasons why approximate rules are still used. When it is desired to quickly and roughly determine the approximate amount of radiation required for a house, the 2-20-200 method given below may be of help.

Each 2 Square Feet of glass requires 1 square foot of steam radiation (Square feet of opening divided by 2)

Each 20 square feet of exposed wall requires 1 square foot of steam radiation (Net exposed wall divided by 20)

Each 200 cubic feet of room volume requires 1 square foot of steam radiation (Cubical content divided by 200)

The above rule is simple and quick and can be used to determine the approximate amount of radiation for a building, but, because of widely varying conditions, it is not accurate, as it fails to properly take into account the various types of construction, exposures, wind velocity, infiltration and temperature differences.

The tendency in recent years has been to depart from old time methods of rule-of-thumb "guesses" as to the apportionment of radiation and to endeavor to determine by more scientific procedure the correct amount of radiation to be installed. To arrive at a scientific basis considerable laboratory and research work has been done and as a result, a vast amount of valuable data has been published. Much of this data, however, is beyond the requirements of the heating contractor and it has been difficult for him to make practical use of it.

Determining Radiation Requirements (continued)

FEELING the need for a simplified but nevertheless scientific method of determining radiation requirements, the Engineers of the National Radiator Corporation, in collaboration with other authorities on the subject, have selected the pertinent facts and have classified them in readily usable form.

The commonly used types of building construction are clearly illustrated in colored diagrams on pages 300 to 307. Accompanying each diagram is a table showing, in column "S" the varying sizes of construction; in column "K" the coefficient of heat transmission, and in column "T" the number of the National Direct-Reading Radiation Table applying to it. The heat transmission coefficients are taken from the latest American Society of Heating & Ventilating Engineers' Guide and were used as a basis in compiling the Direct-Reading Radiation Tables. This value "K" (B.T.U. loss per square foot of surface per hour for 1° temperature) is indicated as a 2-place decimal for the convenience of those who may desire to compute the total B.T.U. loss for a given building. The coefficients of transmission in column "K" need not be considered by the heating contractor in using the Direct-Reading Radiation Tables.

Walls, roofs and partitions may consist of more than a thousand different combinations of building materials. Many of these, however, have approximately the same

Determining Radiation Requirements (continued)

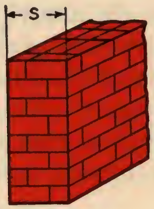
coefficient of heat transmission and it is not, therefore, necessary to have a separate table for each kind of construction. There are twenty Direct-Reading Radiation Tables on pages 308 and 309; these take care of all commonly used types of construction. These tables show the amount of steam radiation required for 5 to 1,000 square feet of surface or lineal feet of crack.

As an illustration; to find the square feet of steam radiation for a quantity of wall surface of the construction shown in Diagram No. 22, page 303, note under "T" that Table No. 6 on page 308 is indicated. Assume that the amount of wall surface is 328 square feet. Opposite 300 in Table 6, Page 308 will be found "23," and opposite 30 (the figure nearest 28) is "2". The total of these, which requires only a mental calculation, is 25 square feet, which is the amount of steam radiation required for 328 square feet of wall surface of the construction shown in Diagram No. 22. For hot water radiation the usual 60% is to be added.

In the same manner the amount of radiation for infiltration through any number of lineal feet of crack around windows and doors may be quickly determined by selecting the proper table shown in Diagram 30.

Factors to correct for varying wind velocities and temperatures are shown on page 310. Factors to correct for room temperatures other than 70° are shown on page 311.

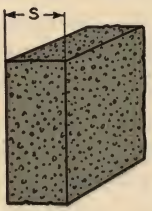
WALLS – BRICK
PLAIN



S	K	T
8″	.39	10
12″	.30	7
16″	.24	5

①

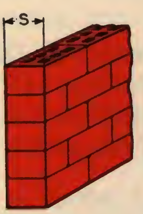
WALLS – CONCRETE
PLAIN



S	K	T
8″	.51	13
10″	.46	12
12″	.41	11
16″	.34	9

②

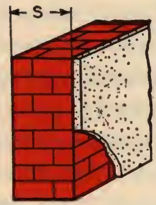
WALLS – HOLLOW TILE
PLAIN



S	K	T
8″	.32	8
10″	.30	7
12″	.24	6
16″	.20	4

③

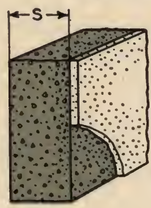
WALLS – BRICK
PLASTER 1 SIDE



S	K	T
8″	.36	9
12″	.28	7
16″	.23	5

④

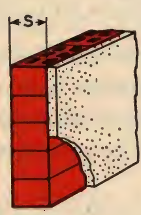
WALLS – CONCRETE
PLASTER 1 SIDE



S	K	T
8″	.46	12
10″	.42	11
12″	.38	10
16″	.32	8

⑤

WALLS – HOLLOW TILE
PLASTER 1 SIDE



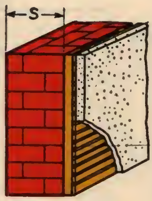
S	K	T
8″	.30	7
10″	.29	7
12″	.23	5
16″	.19	4

⑥

BRICK OR TILE — STONE OR CONCRETE — FRAME — INSULATION

S—Size of material. K—Heat transmission coefficient. T—Table No. (pages 308, 309)

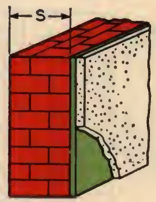
WALLS—BRICK
FURRING, LATH & PLASTER



S	K	T
8"	.25	6
12"	.21	5
16"	.18	4

(7)

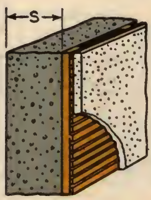
WALLS—BRICK
½" INSULATION & PLASTER



S	K	T
8"	.19	4
12"	.17	3
16"	.15	3

(10)

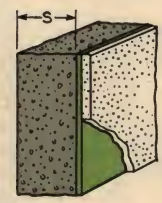
WALLS—CONCRETE
FURRING, LATH & PLASTER



S	K	T
8"	.30	7
10"	.28	7
12"	.26	6
16"	.23	5

(8)

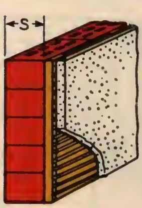
WALLS—CONCRETE
½" INSULATION & PLASTER



S	K	T
8"	.22	5
10"	.21	5
12"	.20	4
16"	.18	4

(11)

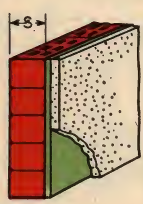
WALLS—HOLLOW TILE
FURRING, LATH & PLASTER



S	K	T
8"	.22	5
10"	.21	5
12"	.18	4
16"	.15	3

(9)

WALLS—HOLLOW TILE
½" INSULATION & PLASTER



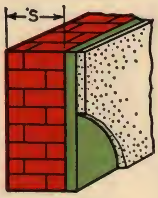
S	K	T
8"	.17	4
10"	.17	3
12"	.15	3
16"	.13	2

(12)

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

S—Size of material. K—Heat transmission coefficient. T—Table No. (pages 308, 309)

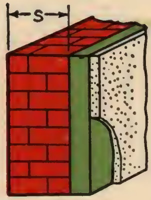
WALLS – BRICK
1" INSULATION & PLASTER



S	K	T
8"	.15	3
12"	.13	2
16"	.12	2

⑬

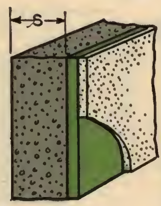
WALLS – BRICK
2" INSULATION & PLASTER



S	K	T
8"	.11	2
12"	.10	1
16"	.09	1

⑯

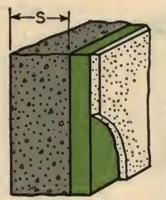
WALLS – CONCRETE
1" INSULATION & PLASTER



S	K	T
8"	.16	3
10"	.16	3
12"	.15	3
16"	.14	3

⑭

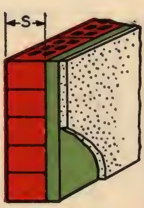
WALLS – CONCRETE
2" INSULATION & PLASTER



S	K	T
8"	.11	2
10"	.11	2
12"	.11	2
16"	.10	1

⑰

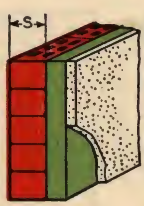
WALLS – HOLLOW TILE
1" INSULATION & PLASTER



S	K	T
8"	.14	3
10"	.13	2
12"	.12	2
16"	.11	2

⑮

WALLS – HOLLOW TILE
2" INSULATION & PLASTER



S	K	T
8"	.10	1
10"	.10	1
12"	.09	1
16"	.08	1

⑱

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

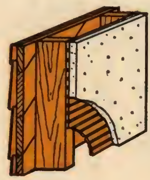
S—Size of material. K—Heat transmission coefficient. T—Table No. (pages, 308, 309)

WALLS–FRAME
CORRUGATED OR FLAT IRON ON STUDS

(19)

S	K	T
	1.5	17

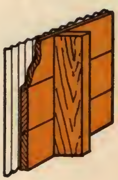
WALLS–FRAME
CLAPBOARDS, 1" SHEATHING, STUDS, LATH & PLASTER



(22)

S	K	T
	.26	6

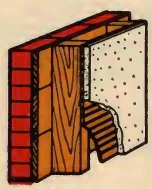
WALLS–FRAME
CORRUGATED OR FLAT IRON, 1" SHEATHING ON STUDS



(20)

S	K	T
	.78	15

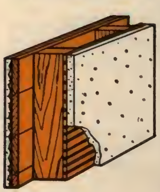
WALLS–FRAME
BRICK VENEER. 1" SHEATHING, STUDS, LATH & PLASTER



(23)

S	K	T
	.25	6

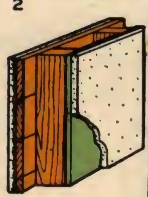
WALLS–FRAME
STUCCO, 1" SHEATHING, STUDS, LATH & PLASTER



(21)

S	K	T
	.30	7

WALLS–FRAME
STUCCO, 1" SHEATHING, STUDS, $\frac{1}{2}$" INSULATION, PLASTER



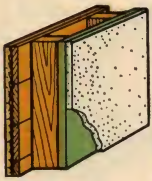
(24)

S	K	T
	.22	5

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

S—Size of material. K—Heat transmission coefficient. T—Table No.(pages 308, 309)

WALLS—FRAME
STUCCO, 1" SHEATHING, STUDS, 1" INSULATION, PLASTER



S	K	T
	.17	3

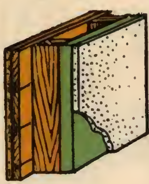
(25)

DOORS, WINDOWS & SKYLIGHTS
SINGLE GLASS

S	K	T
	1.13	16

(28)

WALLS—FRAME
STUCCO, 1" SHEATHING, STUDS, 2" INSULATION, PLASTER



3	K	T
	.10	1

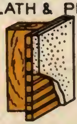
(26)

DOORS, WINDOWS & SKYLIGHTS
DOUBLE GLASS

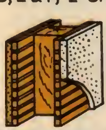
S	K	T
	.45	12

(29)

WALLS—INTERIOR
STUDS, LATH & PLASTER, 1 SIDE



STUDS, L & P, 2 SIDES



S	K	T
	.10	1

(27)

INFILTRATION

	T
PLAIN WINDOWS	18
WEATHERSTRIPPED WINDOWS	11
PLAIN RESIDENCE DOORS	19
WEATHERSTRIPPED DOORS	18
PLAIN STORE DOORS	20
WEATHERSTRIPPED STORE DOORS	19

(30)

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

S—Size of material. K—Heat transmission coefficient. T—Table No. (pages 308, 309)

FLOORS
CONCRETE ON SOIL

S	K	T
4"	.56	14
6"	49	13

(31)

FLOORS & CEILINGS
1" SHEATHING ON JOISTS

K	TEMP. DIFF.	T
.44	30°	4
	50°	8

(34)

FLOORS
WOOD ON CONCRETE

S	K	T
4"	.39	10
6"	.36	9

(32)

FLOORS & CEILINGS
1" SHEATHING ON JOISTS
LATH & PLASTER BELOW

K	TEMP. DIFF.	T
.27	30°	2
	50°	4

(35)

FLOORS
REINFORCED CONCRETE

S	K	TEMP. DIFF.	T
4"	.51	30°	5
		50°	9
6"	.45	30°	4
		50°	8

(33)

FLOORS & CEILINGS
DOUBLE FLOORING
& PAPER ON JOISTS

K	TEMP. DIFF.	T
.34	30°	3
	50°	6

(36)

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

S—Size of material. K—Heat transmission coefficient. T—Table No. (pages 308, 309)

FLOORS & CEILINGS
DOUBLE FLOORING & PAPER
LATH & PLASTER BELOW

K	TEMP. DIFF	T
.23	30°	1
	50°	3

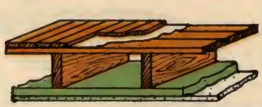
(37)

FLOORS & CEILINGS
DOUBLE FLOORING & PAPER
$\frac{1}{2}$" INSULATION & PLASTER BELOW

K	TEMP. DIFF.	T
.18	30°	1
	50°	2

(38)

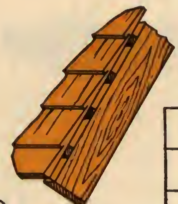
FLOORS & CEILING
DOUBLE FLOORING & PAPER
1" INSULATION & PLASTER BELOW



K	TEMP. DIFF.	T
.11	30°	1
	50°	1

(39)

ROOFS
SHINGLES ON WOOD STRIPS



S	K	T
	.48	13

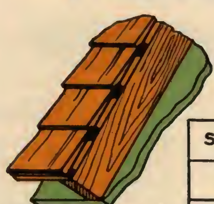
(40)

ROOFS
SHINGLES ON WOOD STRIPS
& $\frac{1}{2}$" INSULATION

S	K	T
	.21	5

(41)

ROOFS
SHINGLES ON WOOD STRIPS
& 1" INSULATION



S	K	T
	.12	2

(42)

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

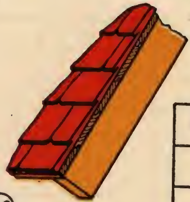
S—Size of material. K—Heat transmission coefficient. T—Table No. (pages 308, 309)

ROOFS
WOOD OR ASPHALT SHINGLES
ON 1" SHEATHING

S	K	T
	.52	13

43

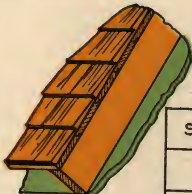
ROOFS
SLATE OR TILE
ON 1" SHEATHING



S	K	T
	.55	14

46

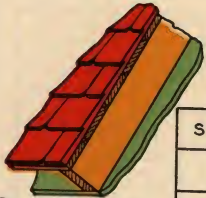
ROOFS
WOOD OR ASPHALT SHINGLES
ON 1" SHEATHING ½" INSULATION



S	K	T
	.22	5

44

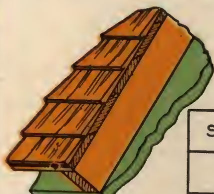
ROOFS
SLATE OR TILE
ON 1" SHEATHING ½" INSULATION



S	K	T
	.22	5

47

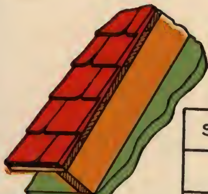
ROOFS
WOOD OR ASPHALT SHINGLES
ON 1" SHEATHING 1" INSULATION



S	K	T
	.16	3

45

ROOFS
SLATE OR TILE
ON 1" SHEATHING 1" INSULATION



S	K	T
	.17	3

48

BRICK OR TILE | STONE OR CONCRETE | FRAME | INSULATION

S—Size of material. K—Heat transmission coefficient. T—Table No. (pages 308, 309)

NATIONAL DIRECT READING RADIATION TABLES

SQUARE FEET OF SURFACE OR LINEAR FEET OF CRACK	SQUARE FEET OF STEAM RADIATION REQUIRED — TABLE NO. 1	2	3	4	5	6	7	8	9	10	SQUARE FEET OF SURFACE OR LINEAR FEET OF CRACK
5	0	0	0	0	0	0	0	1	1	1	5
10	0	0	0	1	1	1	1	1	1	1	10
15	0	1	1	1	1	1	1	1	2	2	15
20	1	1	1	1	1	2	2	2	2	2	20
25	1	1	1	1	2	2	2	2	3	3	25
30	1	1	1	2	2	2	3	3	3	3	30
35	1	1	2	2	2	3	3	3	4	4	35
40	1	1	2	2	3	3	3	4	4	5	40
45	1	2	2	2	3	3	4	4	5	5	45
50	1	2	2	3	3	4	4	5	5	6	50
55	1	2	2	3	4	4	5	5	6	6	55
60	2	2	3	3	4	5	5	6	6	7	60
65	2	2	3	4	4	5	6	6	7	7	65
70	2	2	3	4	5	5	6	7	7	8	70
75	2	3	3	4	5	6	6	7	8	9	75
80	2	3	4	4	5	6	7	8	8	9	80
85	2	3	4	5	6	6	7	8	9	10	85
90	2	3	4	5	6	7	8	9	9	10	90
95	2	3	4	5	6	7	8	9	10	11	95
100	3	4	5	6	7	8	9	10	11	12	100
200	5	7	9	11	13	15	17	19	21	23	200
300	8	11	14	17	20	23	26	29	32	35	300
400	10	14	18	22	26	30	34	38	42	46	400
500	13	18	23	28	33	38	43	48	53	58	500
600	15	21	27	33	39	45	51	57	63	69	600
700	18	25	32	39	46	53	60	67	74	81	700
800	20	28	36	44	52	60	68	76	84	92	800
900	23	32	41	50	59	68	77	86	95	104	900
1000	25	35	45	55	65	75	85	95	105	115	1000

Above tables refer to diagrams pages 300-307.

NATIONAL DIRECT READING RADIATION TABLES

SQUARE FEET OF SURFACE OR LINEAR FEET OF CRACK	SQUARE FEET OF STEAM RADIATION REQUIRED										SQUARE FEET OF SURFACE OR LINEAR FEET OF CRACK
	TABLE NO.										
	11	12	13	14	15	16	17	18	19	20	
5	1	1	1	1	1	2	2	3	7	13	5
10	1	1	1	2	2	3	4	7	13	26	10
15	2	2	2	2	3	5	7	10	20	39	15
20	3	3	3	3	5	7	9	13	26	52	20
25	3	3	4	4	6	8	11	16	33	65	25
30	4	4	4	5	7	10	13	20	39	78	30
35	4	5	5	6	8	12	15	23	46	91	35
40	5	5	6	7	9	13	18	26	52	104	40
45	6	6	7	7	10	15	20	29	59	117	45
50	6	7	7	8	11	16	22	33	65	130	50
55	7	7	8	9	13	18	24	36	72	143	55
60	8	8	9	10	14	20	26	39	79	157	60
65	8	9	9	11	15	21	28	43	85	170	65
70	9	9	10	12	16	23	31	46	92	183	70
75	9	10	11	12	17	25	33	49	98	196	75
80	10	11	12	13	18	26	35	52	105	209	80
85	11	11	12	14	19	28	37	56	111	222	85
90	11	12	13	15	21	30	39	59	118	235	90
95	12	13	14	16	22	31	42	62	124	248	95
100	13	14	15	17	23	33	44	65	131	261	100
200	25	27	29	33	46	66	88	131	262	522	200
300	38	41	44	50	68	99	131	196	393	783	300
400	50	54	58	66	91	132	175	262	524	1044	400
500	63	68	73	83	114	165	219	327	655	1305	500
600	75	81	87	99	137	197	263	392	785	1565	600
700	88	95	102	116	160	230	307	458	916	1826	700
800	100	108	116	132	182	263	350	523	1047	2087	800
900	113	122	131	149	205	296	394	589	1178	2348	900
1000	125	135	145	165	228	329	438	654	1309	2609	1000

Above tables refer to diagrams pages 300-307.

Conversion Factors for Various Temperatures and Wind Velocities

Outside Temper-ature	Wind Velocities—Miles per Hour					
	Sides Exposed to Wind			Sides Not Exposed to Wind		
	15	20	30	15	20	30
—30°	1.7	2.2	3.3	1.5	1.9	2.9
—20°	1.6	2.1	3.1	1.4	1.8	2.7
—15°	1.4	1.9	2.9	1.3	1.7	2.5
—10°	1.3	1.8	2.6	1.2	1.5	2.3
— 5°	1.3	1.7	2.5	1.1	1.5	2.2
— 0°	1.2	1.6	2.3	1.0	1.4	2.0
5°	1.1	1.4	2.2	.95	1.3	1.9
10°	1.0	1.3	2.0	.85	1.2	1.7
15°	.90	1.2	1.8	.80	1.1	1.6
20°	.80	1.1	1.7	.70	.95	1.5
25°	.75	1.0	1.5	.65	.85	1.3

The National Direct Reading Radiation Tables on Pages 308 and 309 are based on 15 mile wind velocity and outside temperature of 0° with an inside temperature of 70°. To correct for a different outside temperature and wind velocity the above conversion factors have been compiled. Multiplying the total radiation by the proper factor will give the amount of radiation needed for a locality where the wind velocity is more than 15 miles per hour and the outside temperature is other than 0.

National *Made-to-Measure* Heating Factor

The amount of radiation required for a room is generally based on a room temperature of 70 degrees. Because this has been the practice, the National Direct Reading Radiation Tables are based on a 70 degree room temperature.

However, in line with the new vogue in heating and the desire to have temperatures other than 70 degrees in certain selected rooms, for certain personal reasons, the following National Made-to-Measure Factor Table has been computed.

Room Temperature	*Made-to-Measure Factor*
60°	.80
65°	.90
68°	.96
70°	1.00
72°	1.04
74°	1.09
76°	1.13
78°	1.18
80°	1.23

To apply the above table, simply multiply the selected temperature factor by the square feet of radiation determined for 70 degrees.

Climatic Conditions Compiled from U. S. Weather Bureau Records

State	City	* Ave. Temp. Oct. 1 to May 1	Lowest Temp.	* Ave. Wind Vel.	Direction of Prevailing Winds
Ala.	Mobile	57.7	−1	8.3	N
	Birmingham	53.9	−10	8.6	N
Ariz.	Phoenix	59.5	16	3.9	E
	Flagstaff	34.9	−25	6.7	SW
Ark.	Fort Smith	49.5	−15	8.0	E
	Little Rock	51.6	−12	9.9	NW
Cal.	San Francisco	54.3	29	....	N
	Los Angeles	58.6	28	....	NE
Colo.	Denver	39.3	−29	7.4	S
	Grand Junction	39.2	−16	5.6	SE
Conn.	New Haven	38.0	−14	9.3	N
D. C.	Washington	43.2	−15	7.3	NW
Fla.	Jacksonville	61.9	10	8.2	NE
Ga.	Atlanta	51.4	−8	11.8	NW
	Savannah	58.4	8	8.3	NW
Idaho	Lewiston	42.5	−13	4.7	E
	Pocatello	36.4	−20	9.3	SE
Ill.	Chicago	36.4	−23	17.0	SW
	Springfield	39.9	−24	10.2	NW
Ind.	Indianapolis	40.2	−25	11.8	S
	Evansville	44.1	−15	8.4	S
Iowa	Dubuque	33.9	−32	6.1	NW
	Sioux City	32.1	−35	12.2	NW
Kans.	Concordia	38.9	−25	7.3	N
	Dodge City	40.2	−26	10.4	NW
Ky.	Louisville	45.2	−20	9.3	SW
La.	New Orleans	61.5	7	9.6	N
	Shreveport	56.2	−5	7.7	SE
Me.	Eastport	31.1	−23	13.8	W
	Portland	33.6	−17	10.1	NW
Md.	Baltimore	43.6	−7	7.2	NW
Mass.	Boston	37.6	−13	11.7	W
Mich.	Alpena	29.1	−27	11.3	W
	Detroit	35.4	−24	13.1	SW
	Marquette	27.6	−27	11.4	NW
Minn.	Duluth	25.1	−41	11.1	SW
	Minneapolis	29.6	−33	11.5	NW
Miss.	Vicksburg	56.0	−1	7.6	SE
Mo.	St. Joseph	40.3	−24	9.1	NW
	St. Louis	43.3	−22	11.8	NW
	Springfield	43.0	−29	11.3	SE
Mont.	Billings	34.7	−49	....	W
	Havre	27.7	−57	8.7	SW
Nebr.	Lincoln	37.0	−29	10.9	N
	North Platte	34.6	−35	9.0	W

*Average temperatures and wind velocities. Heating plants are designed for more extreme conditions.

Climatic Conditions (continued)

State and City		* Ave. Temp. Oct. 1 to May 1	Lowest Temp.	* Ave. Wind Vel.	Direction of Prevailing Winds
Nev.	Tonopah	39.6	−7	9.9	SE
	Winnemucca	37.9	−28	9.5	NE
N. H.	Concord	33.4	−35	6.0	NW
N. J.	Atlantic City	41.6	−7	10.6	NW
N. Y.	Albany	35.1	−24	7.9	S
	Buffalo	34.7	−14	17.7	W
	New York	40.3	−6	13.3	NW
N. M.	Santa Fe	38.0	−13	7.3	NE
N. C.	Raleigh	49.7	−2	7.3	SW
	Wilmington	53.1	5	8.9	SW
N. D.	Bismark	24.5	−45	....	NW
	Devil's Lake	18.9	−44	11.4	W
Ohio	Cleveland	36.9	−17	14.5	SW
	Columbus	39.9	−20	9.3	SW
Okla.	Oklahoma City	48.0	−17	12.0	N
Ore.	Baker	34.1	−20	6.0	SE
	Portland	45.9	−2	6.5	S
Pa.	Philadelphia	41.9	−6	11.0	NW
	Pittsburgh	40.8	−20	13.7	NW
R. I.	Providence	37.6	−9	14.6	NW
S. C.	Charleston	56.9	7	11.0	N
	Columbia	53.7	−2	8.0	NE
S. D.	Huron	28.1	−43	11.5	NW
	Rapid City	32.3	−34	7.5	W
Tenn.	Knoxville	47.0	−16	6.5	SW
	Memphis	50.9	−9	9.6	NW
Texas	El Paso	53.0	−2	10.5	NW
	Fort Worth	54.7	−8	11.0	NW
	San Antonio	60.7	4	8.2	N
Utah	Modena	38.1	−24	8.9	W
	Salt Lake City	40.0	−20	4.9	SE
Vt.	Burlington	29.3	−27	12.9	S
Va.	Norfolk	49.1	2	9.0	N
	Lynchburg	45.2	−7	5.2	NW
	Richmond	47.4	−3	7.4	S
Wash.	Seattle	45.3	3	9.1	SE
	Spokane	37.5	−30	....	SW
W. Va.	Elkins	38.9	−21	4.8	W
	Parkersburg	41.9	−27	6.6	S
Wisc.	Green Bay	28.6	−36	12.8	SW
	La Crosse	31.2	−43	5.6	NW
	Milwaukee	33.0	−25	11.7	W
Wyo.	Sheridan	31.0	−45	5.3	NW
	Lander	28.9	−36	3.0	NE

*Average temperatures and wind velocities. Heating plants are designed for more extreme conditions.

Application of the National *Made-To-Measure* Method

The application of National Direct Reading Radiation Diagrams and Tables will be readily understood from the example of a typical room shown in plan below (Diagram No. 49). Desired room temperature 72°.

As shown on the plan, the room is 15′ x 18′, with 9′ ceiling. Two weather-stripped windows, each 3′ x 6′, in north wall; and one 3′ x 7′ door, not weatherstripped, in west wall.

Wall construction is 8″ brick, furred, lathed and plastered. Adjacent rooms are heated, so no heat loss need be considered through partitions, ceiling or floor.

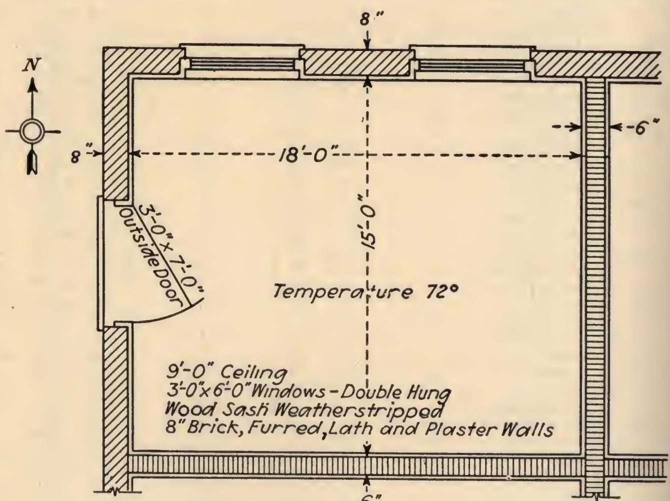


Diagram No. 49

Application of the National *Made-To-Measure* Method (continued)

First compute the north wall and total window area;

$18 \times 9 = 162$ square feet of wall

$2 \times 3 \times 6 = 36$ square feet of window

subtracting, $= 126$ square feet of net brick wall construction

Diagram No. 7, Page 301, covers brick wall, furring, lath and plaster. From this diagram it is seen that an 8″ wall (column "S") indicates (in column "T") Table No. 6 (on page 308). Reading across from either column headed "square feet of surface" it will be noted that 100 square feet of surface in Table 6 calls for 8 square feet of steam radiation. Likewise 25 (the figure nearest 26) square feet of surface calls for 2 square feet of steam radiation, making a total of 10 square feet of radiation for 126 square feet of wall surface.

Diagram No. 28, Page 304, covers windows with single glass. From this diagram it is seen that Table 16, (page 309) is indicated. 35 square feet of surface (the figure nearest 36) calls for 12 square feet of steam radiation.

The lineal feet of infiltration is the distance around each window plus the crack in the meeting rail $(6 + 6 + 3 + 3 + 3) = 21$. For the two windows the total length of crack is 42 feet. Diagram No. 30, page 304, covers infiltration. From this diagram

Application of the National *Made-To-Measure* Method (continued)

it is seen that Table 11 (page 309) is indicated for weather stripped windows. Reading across from 40 (the figure nearest 42) 5 square feet of steam radiation is called for.

The total radiation for the north wall is 27 square feet, made up as follows:

Brick wall surface	10	square	feet
Window surface	12	"	"
Infiltration	5	"	"
Total	27	"	"

In like manner, the west wall and door area are computed as follows:

Wall	15 × 9 = 135		
Door	3 × 7 = 21	= Diagram 28, Table 16 =	7 sq. ft. rad.
Net wall	114	Diagram 7, Table 6 =	9 sq. ft. rad.
Infiltration = 7 × 2 + 3 × 2 =	20	= Diagram 30, Table 19 =	26 sq. ft. rad.
		TOTAL AREA	42 sq. ft. rad.

Summarizing, total radiation required for north wall	= 27 square feet
total radiation required for west wall	= 42 square feet
Total square feet of steam radiation for 70° room temperature, 0° outside temperature	= 69 square feet

Since, in this case, an inside temperature of 72° is to be maintained, the factor 1.04 as shown on page 311 must be considered. Therefore, the full amount of steam radiation required is 69 × 1.04, or 72 square feet.

This installation is to be a National Made-to-Measure Hot Water System in place of steam. The total of 72

Application of the National *Made-To-Measure* Method (continued)

square feet is, therefore, to be increased 60%, making 115 square feet of Hot Water Radiation.

This problem assumes an outside temperature of 0° and a wind velocity of 15 miles per hour, the conditions on which National Direct-Reading Radiation Tables are based. The conversion factors on page 310, therefore, need not be considered. If the outside temperature were —10° and the wind velocity 20 miles per hour, the total radiation shown above would be multiplied by 1.5 for sides not exposed and 1.8 for sides exposed.

Selection of the Proper Radiator

This may readily be done by following the instructions on pages 318 and 319.

It is probable, in this example, that the radiator location selected would be against the north wall and below the windows; also that radiators 26″ high will be used.

Since the total required radiation is 115 square feet, two radiators will be needed, each of 57½ square feet capacity.

Referring to the Radiation Chart on page 323, it is seen that a 16-section 5-tube radiator 26″ high has a capacity of 56 square feet, which is close enough for the purpose. Since this radiator is 40″ long, and will extend but 2″ on each side of the window opening, it may be considered satisfactory.

How to Select the Proper Type and Size of Radiation

The following charts show the number of square feet of National Aero Radiation in various lengths, widths and heights. Their use will facilitate determining the dimensions of a radiator that will conform to a given space and provide the desired number of square feet of radiation.

The procedure is simple.

1. Determine the number of square feet of radiation required for a given room.

2. Select desired location of radiators after considering exposure, and wall space required for furniture.

3. Decide the number of radiators required.

4. Decide the dimension or dimensions of the radiator which are limited by the space available. For example, suppose the height must not exceed 27 inches, the length 44 inches, and that the radiation must be not less than 40 square feet.

5. Refer to the radiation charts. Chart No. 1 "G" covers radiators 26 inches high—these are nearest to the permitted height.

6. Locate the desired length in column "B". At the point of intersection between the height group selected, and the length desired, you will find the number of square feet of radiation available in radiators with various numbers of tubes. In the case above, you will have a choice of:

(A.) a 3-tube, 42½ inches long, with 39⅔ sq. ft. of radiation.

(B.) a 4-tube, 37½ inches long, with 41¼ sq. ft. of radiation.

(C.) a 5-tube, 30 inches long, with 42 sq. ft. of radiation.

(D.) a 6-tube, 25 inches long, with 40 sq. ft. of radiation.

(E.) a 7-tube, 22½ inches long, with 42¾ sq. ft. of radiation.

7. Choose from these various possibilities the proportions that will present the most pleasing appearance.

Chart No. 1

A	B	C	D
		13½"*	16½"*
Number of Sections	Radiator Length in Inches	No. Tubes	No. Tubes
		7	7
		Sq. Ft.	Sq Ft.
1	2½	2½	3
2	5	5	6
3	7½	7½	9
4	10	10	12
5	12½	12½	15
6	15	15	18
7	17½	17½	21
8	20	20	24
9	22½	22½	27
10	25	25	30
11	27½	27½	33
12	30	30	36
13	32½	32½	39
14	35	35	42
15	37½	37½	45
16	40	40	48
17	42½	42½	51
18	45	45	54
19	47½	47½	57
20	50	50	60
21	52½	52½	63
22	55	55	66
23	57½	57½	69
24	60	60	72
25	62½	62½	75
26	65	65	78
27	67½	67½	81
28	70	70	84
29	72½	72½	87
30	75	75	90
Width of Sections		12"	12"

*Height of Radiators.

Chart No. 1 (cont.)

A	B	E				
		20″ High Radiators				
Number of Sections	Radiator Length in Inches	No. of Tubes				
		3	4	5	6	7
		Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
1	2½	1¾	2¼	2⅔	3	3⅔
2	5	3½	4½	5⅓	6	7⅓
3	7½	5¼	6¾	8	9	11
4	10	7	9	10⅔	12	14⅔
5	12½	8¾	11¼	13⅓	15	18⅓
6	15	10½	13½	16	18	22
7	17½	12¼	15¾	18⅔	21	25⅔
8	20	14	18	21⅓	24	29⅓
9	22½	15¾	20¼	24	27	33
10	25	17½	22½	26⅔	30	36⅔
11	27½	19¼	24¾	29⅓	33	40⅓
12	30	21	27	32	36	44
13	32½	22¾	29¼	34⅔	39	47⅔
14	35	24½	31½	37⅓	42	51⅓
15	37½	26¼	33¾	40	45	55
16	40	28	36	42⅔	48	58⅔
17	42½	29¾	38¼	45⅓	51	62⅓
18	45	31½	40½	48	54	66
19	47½	33¼	42¾	50⅔	57	69⅔
20	50	35	45	53⅓	60	73⅓
21	52½	36¾	47¼	56	63	77
22	55	38½	49½	58⅔	66	80⅔
23	57½	40¼	51¾	61⅓	69	84⅓
24	60	42	54	64	72	88
25	62½	43¾	56¼	66⅔	75	91⅔
26	65	45½	58½	69⅓	78	95⅓
27	67½	47¼	60¾	72	81	99
28	70	49	63	74⅔	84	102⅔
29	72½	50¾	65¼	77⅓	87	106⅓
30	75	52½	67½	80	90	110
Width of Sections		5⅛″	6 13/16″	8 13/32″	9″	12″

Chart No. 1 (cont.)

A	B	F			
		23″ High Radiators			
		No. of Tubes			
Number of Sections	Radiator Length in Inches	3	4	5	6
		Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
1	2½	2	2½	3	3½
2	5	4	5	6	7
3	7½	6	7½	9	10½
4	10	8	10	12	14
5	12½	10	12½	15	17½
6	15	12	15	18	21
7	17½	14	17½	21	24½
8	20	16	20	24	28
9	22½	18	22½	27	31½
10	25	20	25	30	35
11	27½	22	27½	33	38½
12	30	24	30	36	42
13	32½	26	32½	39	45½
14	35	28	35	42	49
15	37½	30	37½	45	52½
16	40	32	40	48	56
17	42½	34	42½	51	59½
18	45	36	45	54	63
19	47½	38	47½	57	66½
20	50	40	50	60	70
21	52½	42	52½	63	73½
22	55	44	55	66	77
23	57½	46	57½	69	80½
24	60	48	60	72	84
25	62½	50	62½	75	87½
26	65	52	65	78	91
27	67½	54	67½	81	94½
28	70	56	70	84	98
29	72½	58	72½	87	101½
30	75	60	75	90	105
Width of Sections		5⅛″	6 13/16″	8 13/32″	9″

Chart No. 1 (cont.)

A	B	G				
		26″ High Radiators				
		No. of Tubes				
Number of Sections	Radiator Length in Inches	3	4	5	6	7
		Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
1	2½	2⅓	2¾	3½	4	4¾
2	5	4⅔	5½	7	8	9½
3	7½	7	8¼	10½	12	14¼
4	10	9⅓	11	14	16	19
5	12½	11⅔	13¾	17½	20	23¾
6	15	14	16½	21	24	28½
7	17½	16⅓	19¼	24½	28	33¼
8	20	18⅔	22	28	32	38
9	22½	21	24¾	31½	36	42¾
10	25	23⅓	27½	35	40	47½
11	27½	25⅔	30¼	38½	44	52¼
12	30	28	33	42	48	57
13	32½	30⅓	35¾	45½	52	61¾
14	35	32⅔	38½	49	56	66½
15	37½	35	41¼	52½	60	71¼
16	40	37⅓	44	56	64	76
17	42½	39⅔	46¾	59½	68	80¾
18	45	42	49½	63	72	85½
19	47½	44⅓	52¼	66½	76	90¼
20	50	46⅔	55	70	80	95
21	52½	49	57¾	73½	84	99¾
22	55	51⅓	60½	77	88	104½
23	57½	53⅔	63¼	80½	92	109¼
24	60	56	66	84	96	114
25	62½	58⅓	68¾	87½	100	118¾
26	65	60⅔	71½	91	104	123½
27	67½	63	74¼	94½	108	128¼
28	70	65⅓	77	98	112	133
29	72½	67⅔	79¾	101½	116	137¾
30	75	70	82½	105	120	142½
Width of Sections		5⅛″	$6\frac{13}{16}$″	$8\frac{13}{32}$″	9″	12″

Chart No. 1 (cont.)

A	B	H				I
		30″ High Radiators				32″*
Number of Sections	Radiator Length in Inches	No. of Tubes				No. Tubes
		3	4	5	7	6
		Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
1	2½	3	3½	4⅓	5½	5
2	5	6	7	8⅔	11	10
3	7½	9	10½	13	16½	15
4	10	12	14	17⅓	22	20
5	12½	15	17½	21⅔	27½	25
6	15	18	21	26	33	30
7	17½	21	24½	30⅓	38½	35
8	20	24	28	34⅔	44	40
9	22½	27	31½	39	49½	45
10	25	30	35	43⅓	55	50
11	27½	33	38½	47⅔	60½	55
12	30	36	42	52	66	60
13	32½	39	45½	56⅓	71½	65
14	35	42	49	60⅔	77	70
15	37½	45	52½	65	82½	75
16	40	48	56	69⅓	88	80
17	42½	51	59½	73⅔	93½	85
18	45	54	63	78	99	90
19	47½	57	66½	82⅓	104½	95
20	50	60	70	86⅔	110	100
21	52½	63	73½	91	115½	105
22	55	66	77	95⅓	121	110
23	57½	69	80½	99⅔	126½	115
24	60	72	84	104	132	120
25	62½	75	87½	108⅓	137½	125
26	65	78	91	112⅔	143	130
27	67½	81	94½	117	148½	135
28	70	84	98	121⅓	154	140
29	72½	87	101½	125⅔	159½	145
30	75	90	105	130	165	150
Width of Sections		5⅛″	6 13/16″	8 13/32″	12″	9″

*Height of Radiators.

Chart No. 1 (cont.)

A	B	J				K
		36″ High Radiators				38″*
		No. of Tubes				No. Tubes
Number of Sections	Radiator Length in Inches	3	4	5	7	6
		Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.	Sq. Ft.
1	2½	3½	4¼	5	6¾	6
2	5	7	8½	10	13½	12
3	7½	10½	12¾	15	20¼	18
4	10	14	17	20	27	24
5	12½	17½	21¼	25	33¾	30
6	15	21	25½	30	40½	36
7	17½	24½	29¾	35	47¼	42
8	20	28	34	40	54	48
9	22½	31½	38¼	45	60¾	54
10	25	35	42½	50	67½	60
11	27½	38½	46¾	55	74¼	66
12	30	42	51	60	81	72
13	32½	45½	55¼	65	87¾	78
14	35	49	59½	70	94½	84
15	37½	52½	63¾	75	101¼	90
16	40	56	68	80	108	96
17	42½	59½	72¼	85	114¾	102
18	45	63	76½	90	121½	108
19	47½	66½	80¾	95	128¼	114
20	50	70	85	100	135	120
21	52½	73½	89¼	105	141¾	126
22	55	77	93½	110	148½	132
23	57½	80½	97¾	115	155¼	138
24	60	84	102	120	162	144
25	62½	87½	106¼	125	168¾	150
26	65	91	110½	130	175½	156
27	67½	94½	114¾	135	182¼	162
28	70	98	119	140	189	168
29	72½	101½	123¼	145	195¾	174
30	75	105	127½	150	202½	180
Width of Sections		5⅛″	6 13/16″	8 13/32″	12″	9″

*Height of Radiators.

Proving Temperature Guarantees in Warm Weather

National Heating Specialists may prove temperature guarantees during warm weather by using the following table prepared by R. C. Carpenter. It is arranged on the basis of proving a 70° house temperature guarantee.

Outside Temperature at Time of Test	Inside Temperature at Time of Test	Outside Temperature at Time of Test	Inside Temperature at Time of Test
−10	64.7	35	89.8
− 7.5	66.0	37.5	91.5
− 5	67.3	40	93.1
− 2.5	68.7	42.5	94.5
0	70	45	95.9
2.5	71.3	47.5	97.3
5	72.6	50	98.7
7.5	73.9	52.5	100.2
10	75.1	55	101.7
12.5	76.6	57.5	103.2
15	78	60	104.7
17.5	79.5	62.5	106.2
20	81	65	107.6
22.5	82.4	67.5	109.1
25	83.8	70	110.5
27.5	85.2	72.5	112.2
30	86.5	75	113.8
32.5	88.2	77.5	115.4
		80	117.1

Heating tests made in warm weather should be conducted for a period not less than 24 hours.

Selecting the Right Boiler for the Job

WHEN selecting a boiler, consideration should be given to the height of the boiler room, the location of inlet to the chimney and the draft intensity and fuel to be used.

If a steam or vapor heating system is to be installed, it is essential that a steam boiler be selected, the water line of which will be from 18 to 30 inches below the low point of the main to take care of the inequality in pressure in the system (see explanation, page 350). National Low Water Line Boilers are particularly well adapted for installation where headroom is at a premium.

If the draft intensity is below normal, a boiler should be selected which does not have an abnormally long fire travel. For instance, if a round boiler is to be installed under these conditions, it is advisable to select a boiler with sufficient rated capacity to carry the radiation and which has only one intermediate section.

If the opening to the chimney is low, and it is impossible to provide a new opening at a higher point, it is advisable to select a boiler, the smoke outlet of which is taken from the rear of the boiler instead of from the top, so that it will not be necessary to pitch the smoke pipe down, which is always bad practice.

If coke is to be used as fuel, a boiler with fire box at least 20″ deep should be selected. If high volatile coal is to be used select a smokeless boiler.

Radiator Heating Systems—Types and Applications

Generally speaking, there are six accepted types of radiator heating systems:

(1) Hot water heating system closed—with or without tank.

(2) Hot water heating system open—with tank.

(3) One-Pipe Steam Heating System; same pipe carries steam to, and condensate from, the radiator.

(4) Two-Pipe Steam Heating System; one pipe carries steam to radiator; other pipe carries condensate water from the radiator.

(5) Vapor Heating System; similar to two-pipe steam system, but operates under very low pressure.

(6) Vacuum Heating System; air is removed from radiators and piping, usually by means of a pump. System operates at below atmospheric pressure.

Hot Water Heating Systems

In hot water heating systems the boiler, radiators and pipes are kept filled with water. The expansion of water when heated sets up a circulation; consequently the warm water rises to the radiators, where the heat is given off. As the water cools, it returns to the boiler, being displaced in the radiator by the incoming hotter water.

Each pound of water in this system gives off one British Thermal Unit (usually written B. T. U., the unit of measurement of heat) for each degree the water cools.

Hot water heating systems differ from all other types of heating systems in that they depend on water to convey the heat from the boilers to the radiators. A hot water heating system consists of: the boiler, the main flow pipe and branches, the radiators, the return pipe and branches, and the expansion or pressure tank. (A relief valve is sometimes used on closed systems, instead of a tank.)

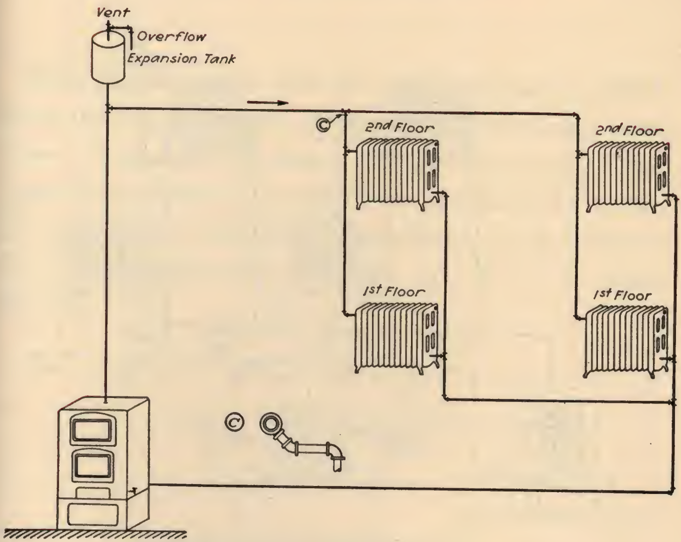
Since water expands when heated, it is necessary to provide for this expansion by attaching a tank or relief valve. The motive force which causes the water to circulate is very low, being equal only to the difference in the

Hot Water Heating Systems (continued)

weight of the hotter water in the flow pipe and the weight of the cooler water in the return pipe.

A difference in temperature of 20 degrees produces a weight of less than one-half pound; consequently it is necessary to observe every precaution to reduce friction, avoid air pockets, provide an easy and free flow of water, and apportion the piping so that all radiators are equally supplied. In short, it is necessary to observe the utmost care in calculating pipe sizes (described later) so that the system will be "balanced", which is necessary for proper operation.

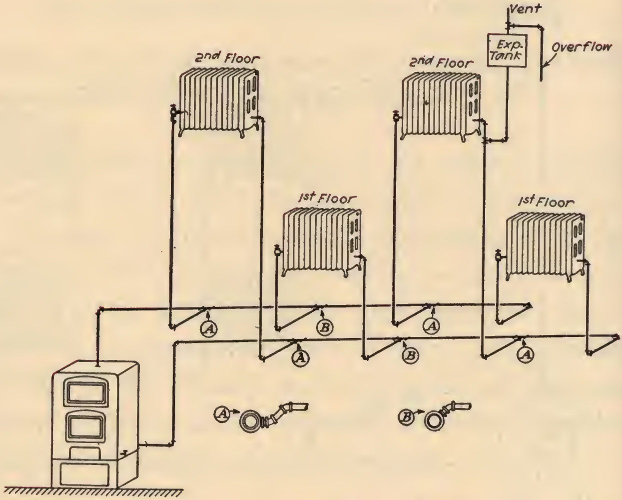
Hot water heating systems have been favorably looked upon because of their even heating qualities—that is, once the water is heated and in circulation, the radiators continue to give off warmth, even though the fire burns low. An added advantage is that in mild weather a light fire will keep the water in circulation at a temperature as low as 80° to 100°, thereby furnishing very mild warmth. The even heating qualities of hot water systems are further improved when automatic damper regulation is part of the equipment.



HOT WATER OPEN SYSTEM — 1 PIPE OVERHEAD

Hot Water Open System— One-Pipe Overhead

ONE-PIPE overhead hot water open systems are used in buildings where there is limited cellar space and in installations where the boiler is placed on the same floor level as the lowest radiators. The supply main is then run to the roof space, and drop risers taken from this main to the radiators. An air valve is placed on high point of main, if the expansion tank is not located so that air will vent freely through the tank.



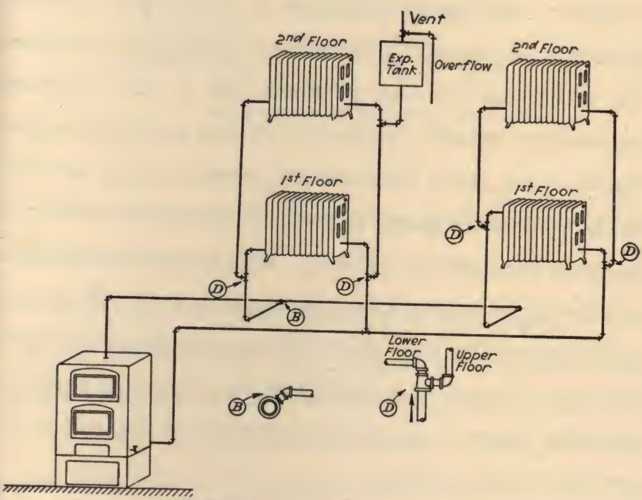
HOT WATER OPEN SYSTEM — 2 PIPE UPFEED
SHOWING SEPARATE SETS OF RISERS TO EACH RADIATOR

Hot Water Open System—Two-Pipe Upfeed

TWO-PIPE upfeed hot water systems are used in most normal situations. They consist of a main feed pipe supplying hot water to radiators and a return main pipe which returns the cooler water to the boiler for re-heating. Air valves are placed on all radiators at the top of the return end.

These two diagrams show two methods of piping the radiators for an open hot water system.

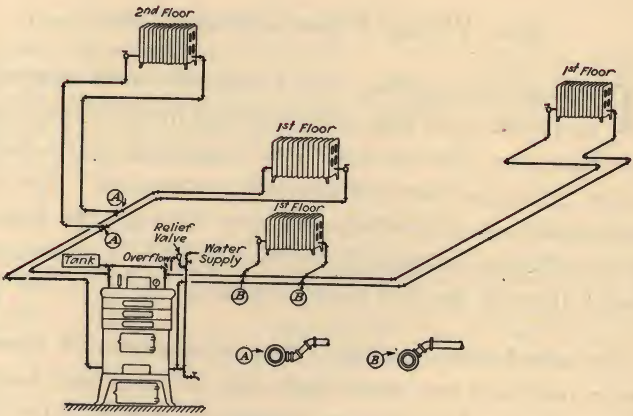
Note that in these, and the other diagrams of Hot Water Heating Systems, recommended connections are shown, designated by a letter. The points at which these connections should be installed are indicated by corresponding letters. Complete descriptions of the connections, and reasons for their use, are given on pages 336-337.



HOT WATER OPEN SYSTEM — 2 PIPE UPFEED
SHOWING FIRST AND SECOND FLOOR RADIATORS CONNECTED TO THE SAME SUPPLY AND RETURN RISERS

Closed Hot Water Heating Systems

THE closed hot water heating system has no expansion tank open to the atmosphere. The entire system is so designed that the water has no access to the atmosphere except through a pressure relief valve. The purpose of such an arrangement is to provide a pressure (generally 10 pounds) greater than atmospheric pressure. The advantage of this pressure lies in the increased temperature secured before the boiling point is reached. Water at sea level atmospheric pressure boils at 212°, but at 10 pounds gauge pressure it does not boil until it reaches a temperature of 239.4°. This greater temperature provides greater heat for each pound of water. It permits installing smaller pipe sizes. The temperature of the hot water in radiators in a closed hot water heating system is generally higher than the temperature of the water in a gravity or open system.



CLOSED HOT WATER HEATING SYSTEM WITH TANK IN BASEMENT

The diagram above shows a typical installation of this character.

Note that in these, and the other diagrams of Hot Water Heating Systems, recommended connections are shown, designated by a letter. The points at which these connections should be installed are indicated by corresponding letters. Complete descriptions or the connections, and reasons for their use, are given on pages 336-337.

Hot Water Pipe Connections

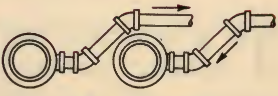
THE natural tendency of hot water is to flow upward, and if the same type of connections from the mains to the risers are used on first floor risers and upper floor risers, the upper floor radiators will be "favored"; that is, practically all of the flow will pass through the upper floor radiators, and there will be very little if any circulation through the first floor radiators.

To avoid this condition, riser connections to upper floor radiators are taken from side of main and lower floor radiators from the top of main. An exception to this is an unusually large radiator located near the boiler on the first floor, the connection to which is usually taken from the side of the main, to prevent this large radiator from taking the entire flow.

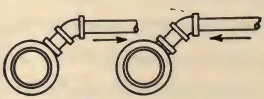
Especial care should be taken to ream the ends of all pipes, as burrs left on the inside of the pipe will reduce the pipe area, and restrict the circulation. Eccentric reducing fittings should be used when reducing the size of main. Care should be taken to have the straight side of the fitting on the upper side of the flow main, and on the bottom side of the return main.

The following connections are recommended for use with hot water heating systems and should be carefully studied and followed in laying out an installation:

Connection **A** is used when supplying risers to upper floors and for large first-floor radiators. It should not be used after a reduction in the size of the main occurs, as an air pocket might be formed.



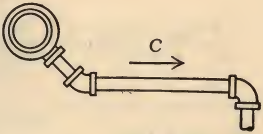
A

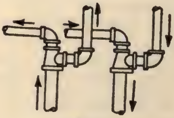


B

Connection **B** is used for the last riser before a main is reduced in size and for first-floor radiators located at some distance from the boiler. One of the objects of the **B** connection is to vent the main pipe when a reduction is made.

Connection **C** is used only when radiators are located below the main, as in overhead piping systems.

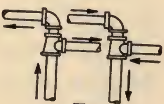




D

Connection **D** is the proper method of taking off branches from a riser when same is to be extended to a higher floor. The second floor radiator should be taken from the top opening of the tee and the third floor riser should connect to the side opening.

Connection **E** is the correct method of supplying from one riser two radiators that are located on the same floor. The connection to the larger radiator should be taken from the top opening of the tee, and the connection to the smaller radiator should be taken from the side.



E

Balancing an Open Hot Water Heating System

IT is important that a hot water heating system be carefully balanced in order that all radiators will be supplied with the proper amount of hot water. By using the following tables the proper sizes of risers and mains may be accurately determined. Chart No. 2 shows the required nominal riser pipe sizes in inches for radiators located varying distances, up to 100 feet, above the boiler. *Note:* Radiation figures given are maximum; that is, a ¾ inch pipe will supply 1 to 40 feet of radiation located 10 feet above boiler. A 1-inch pipe will supply 41 to 70 feet; and so on.

Chart No. 2 - Pipe Sizes for Open Hot Water Heating System

Nominal Pipe Size Required —Inches	Distance of Radiators above boiler in feet.									
	10′	20′	30′	40′	50′	60′	70′	80′	90′	100′
	Square Feet of Radiation Allowable									
¾″	40	50	60	70	80	90	100	110	120	135
1″	70	80	90	100	110	120	130	140	150	160
1¼″	110	120	135	150	160	175	185	200	210	225
1½″	180	195	210	230	250	265	285	300	315	330
2″	300	350	400	500	575	625	700	775	825	900

Examples of application of chart. (Open Tank Hot Water Heating System).

Example: What size riser will be required to supply 120 square feet of hot water radiation on the 4th floor 60 feet above boiler?

Solution: In column headed 60 feet the second figure is 120; carry across to first column and 1″ pipe is found to be the required size.

Example: If the above 120 sq. ft. of radiation is on the second floor 20 feet above boiler, what size riser will be required?

Solution: Opposite 120 in column headed 20 feet is noted 1¼″ pipe, the required size.

Determination of Correct Size of Main— Hot Water Heating System

To determine the size of main required to take care of various branches, select from the table below the factor for each branch; add them together; the total gives the factor for the main. The size of the required main is shown at the top of the column.

Chart No. 3

Factors to be Used in Proportioning Sizes of Mains

Nominal Size of Pipe—Inches	¾	1	1¼	1½	2	2½	3	4	5	6	8
Factor	5	10	20	30	60	110	175	380	650	1050	2250

Example: What size main will be required to supply 5-¾″ risers, 4-1″ risers and 5-1¼″ risers?

Solution: The factor for ¾″ is 5, there are 5 risers— 5 x 5 = 25
The factor for 1″ is 10, there are 4 risers—10 x 4 = 40
The factor for 1¼″ is 20, there are 5 risers—20 x 5 = 100
Total 165

Follow across factor column until the number 165, or the next greater number (which is 175) is reached. The pipe size listed directly above—3 inches—is the size of main required.

Balancing a Closed Hot Water System

IT is essential that closed hot water systems be carefully balanced in order that all radiators be supplied with a proper amount of hot water. By using the following tables, the proper sizes of risers and mains may be accurately determined. In Chart No. 4 are shown the various pipe sizes for the various square feet of radiation for each floor of a four story building.

In order to determine the proper pipe size for each situation, simply locate the number of square feet of radiation under the proper floor location (or the number next greater). The figures in the first left hand column in the same line will indicate the pipe size to be used.

Chart No. 4—Pipe Sizes for Closed Hot Water Heating Systems

Pipe Size—Inches	First Floor	Second Floor	Third Floor	Fourth Floor
	Sq. Ft. of Radiation	Sq. Ft. of Radiation	Sq. Ft. of Radiation	Sq. Ft. of Radiation
½″	30	40	50	60
¾″	60	75	90	110
1″	110	120	135	150
1¼″	165	180	200	225
1½″	270	290	315	350
2″	450	525	600	750

Example: What size riser will be required to supply 120 square feet of hot water radiation on the 1st floor.

Solution: In column headed first floor, 120 does not appear. The next greater number is 165. Therefore, the pipe size corresponding to 165—1¼ inch—should be selected.

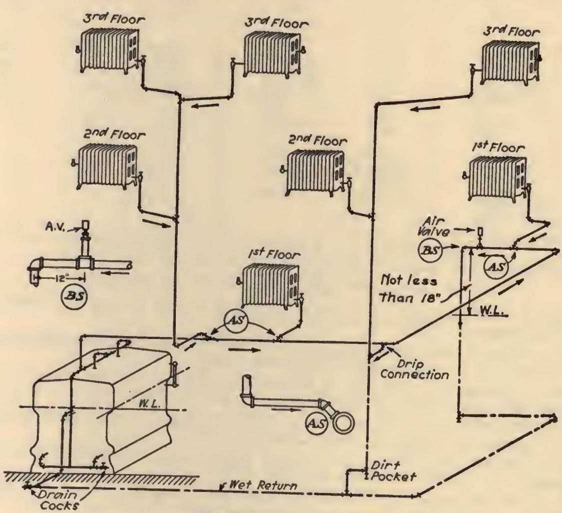
Example: If above radiation is on 2nd floor, what size pipe will be required?

Solution: Under column headed second floor and opposite 120, a 1″ pipe is listed and will be required.

Steam Heating Systems

One-Pipe Steam System

A ONE-PIPE steam heating system is the least expensive type of radiator installation. Ordinarily a pressure of about 2 pounds is maintained. The pipe leading to the radiators is used also for a return for the condensate. Each radiator is equipped with an air and a steam valve. The mains should be pitched down, in the direction of the flow of steam, and all branches should pitch down toward riser or main to permit the return of condensate. Supply main should drop into a wet return. (A Wet Return is a pipe located below the boiler water line, usually at basement floor level, which returns the condensate to the boiler.) It is good practice to have the vent placed on the far end of the supply main so that any air in the system will be promptly expelled. A high grade air valve on each radiator will add materially to the proper functioning of the system. See pages 353 to 359 for recommended connections.



ONE PIPE STEAM SYSTEM

Determination of Correct Size of Main—

One-Pipe Steam Systems

It is recommended that care be used in selecting the proper size and arrangement of piping. Chart No. 5, prepared and copyrighted by the American Society of Heating and Ventilating Engineers and the Heating and Piping Contractors National Association, shows the various pipe sizes for meeting various one-pipe gravity low pressure steam heating system requirements.

Chart No. 5 shows correct pipe sizes for one-pipe gravity low pressure steam heating systems where equivalent length of run from boiler or source of supply to the farthest radiator does not exceed 200 feet. The capacities in square feet of equivalent radiation are shown in columns B to G inclusive opposite the correct pipe sizes for the various conditions encountered.

Chart No. 5

Pipe Size Inches	Supply Main Dripped and Branches to Risers Dripped Steam and Condensate flowing in the same direction	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Wet Return Main	Dry Return Main	Radiator Valve Sizes and Vertical Connections
A	B	C	D*	E	F	G
¾	..	25	..	...	...	..
1	56	45	20	700	320	20
1¼	122	98	55	1200	670	55
1½	190	152	81	1900	1058	81
2	386	288	165	4000	2300	165
2½	635	464	260	6700	3800	...
3	1163	799	475	10,700	7000	...
4	2457	1520	1110	......	......	...
5	4546	....	2180	......	......	...
6	7462	....	....	......	......	...

*Radiator branches more than 8 feet in length should be one size larger than shown in Column D.

Note 1—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2—Capacities based on ¼ lb. condensation per square foot per hour equivalent radiation and on actual diameter of standard pipe.

Note 3—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. (See chart 9.)

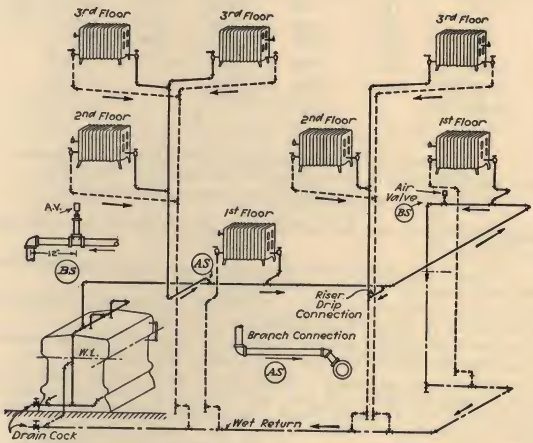
Note 4—Where it is necessary to drip a steam main, branch to riser, or risers, same should be dripped separately into wet return.

Note 5—Pitch of mains should be not less than ¼ inch in 10 feet; on horizontal branches to radiators and risers should pitch at least ½ inch in 10 feet.

Two-Pipe Steam System

The two-pipe steam heating system employs two pipes— one pipe leading from the boiler supplying steam to the radiator, and one pipe leading from the radiator returning condensate to the boiler. The return line drops into a wet return. A pressure of 2 to 5 pounds is generally carried. The radiator branches should pitch downward from the radiators. The riser branches should pitch downward toward the main. Each radiator is equipped with a valve on both supply and return ends; also with an air valve on the return end. It is good practice to place an air valve on the far end of the main for the expulsion of any air in the main.

The diagram below shows a typical two-pipe steam heating system. See pages 353 to 359 for recommended connections.



TYPICAL TWO PIPE STEAM SYSTEM

Determination of Correct Size of Main

Two-Pipe Steam Heating System

Care must also be exercised in selecting the proper size and arrangement of piping in the two-pipe system. Chart No. 6 shows the correct pipe sizes for two-pipe gravity low pressure steam heating systems where equivalent length of run from boiler or source of supply to the farthest radiator does not exceed 200 feet. The capacities in square feet of equivalent radiation are shown in columns B to I inclusive opposite the correct pipe sizes for the various conditions encountered.

Chart No. 6

Pipe Sizes Inches	Supply Main Dripped and Branches to Risers Dripped Steam and Condensate Flowing in same Direction	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Return Risers	Wet Return Main	Dry Return Main	Radiator Supply Valve	Radiator Return Valve
A	B	C	D*	E	F	G	H	I
¾	..	30	..	122	...	...	30	122
1	56	56	26	320	700	320	56	190
1¼	122	122	58	670	1200	670	122	386
1½	190	190	95	1058	1900	1058	190	...
2	386	386	195	2300	4000	2300	386	...
2½	635	635	395	3800	6700	3800	...	...
3	1163	1129	700	7000	10,700	7000	...	...
4	2457	2042	1700	.....	.....	.....	...	...
5	4546	....	3150	.....	.....	.....	...	...
6	7462	....	....	.....	.....	.....	...	...

*Radiator branches more than 8 feet in length should be one size larger than shown in Column D.

Note 1—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2—Capacities based on ¼ lb. condensation per square foot per hour equivalent radiation and on actual diameter of standard pipe.

Note 3—Extra length to be added to straight run of pipe for various fittings and valves to determine equivalent length. (See chart 9, page 349.)

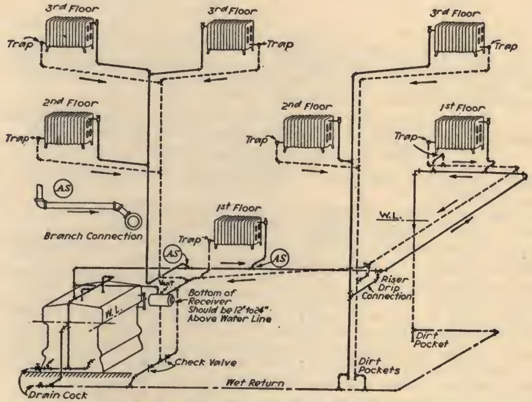
Note 4—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately into a wet return or through an adequate seal into a dry return. Never drip a supply pipe into a dry return except through an adequate seal.

Note 5—Pitch of main should not be less than ¼ inch in 10 feet; on horizontal branches to radiators, and risers at least ½ inch in 10 feet.

Vapor Heating Systems

Two-Pipe Gravity Vapor System

The vapor system is similar to the two-pipe steam system only so far as the supply and return lines are concerned. Each radiator is supplied through a graduating valve, attached to the top connection of the radiator. A trap is connected on the return side at the bottom. The return risers and branches are collected into a dry return. (A dry return is a pipe located preferably 18 inches or more above the boiler water line, which returns the condensate to the receiver.) This dry return connects to a receiver near the boiler. This receiver eliminates air, and allows the condensate to drop into the wet return. This system operates at atmospheric pressure, or under a slight vacuum. There are no air valves on the radiators. The air in the system is eliminated through air valves placed on the receiver and mains.



TYPICAL TWO PIPE GRAVITY VAPOR SYSTEM WITH RECEIVER

Determination of Correct Sizes of Risers and Main

Two-Pipe Gravity Vapor Heating Systems

Care must be used in selecting the proper size and arrangement of piping in this installation. Chart No. 7 shows the correct pipe sizes for two-pipe gravity type vapor heating systems where equivalent length of run from boiler or source of supply to the farthest radiator does not exceed 200 feet. The capacities in square feet of equivalent radiation are shown opposite the correct pipe sizes for the various conditions encountered.

Chart No. 7

Pipe Size Inches	Supply Main Dripped and Branches to Risers Dripped Steam and Condensate flowing in same direction	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Return Risers	Wet Return Main	Dry Return Main
A	B	C	D*	E	F	G
¾	..	30	..	190	...	...
1	56	56	26	450	700	320
1¼	122	122	58	990	1200	670
1½	190	190	95	1500	1900	1058
2	386	386	195	3000	4000	2300
2½	635	635	395	....	6700	3800
3	1163	1129	700	....	10,700	7000
4	2457	2042	1700	....	......	......
5	4546	....	3150	....	......	......
6	7462	....	....	....	......	......

Different makes of supply and return valves, steam traps, and other specialties vary as to capacity, therefore use size as recommended by manufacturer for any particular make. Vertical connections to be of same size as valve and trap used. Return horizontal runout to be not less than ¾ inch.

*Radiator branches more than 8 feet in length should be one size larger than shown in Column D.

This table is for systems which are open to atmosphere or operate under slight pressure or partial vacuum without use of vacuum pumps.

Note 1—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2—Capacities based on ¼ lb. condensation per square foot per hour equivalent radiation and on actual diameter of standard pipe.

Note 3—Extra length to be added to straight run of pipe for various fittings and valves to determine equivalent length. (See chart 9, page 349.)

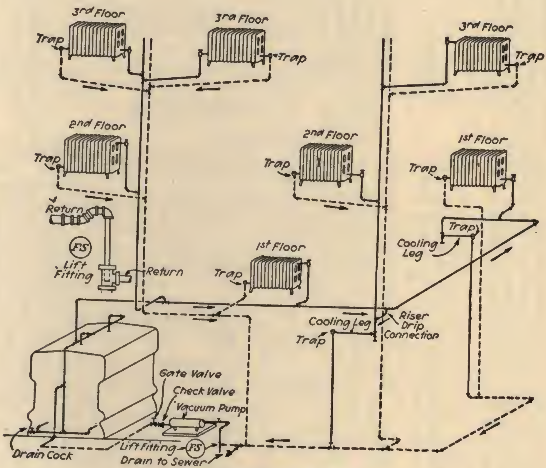
Note 4—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately into a wet return. The drip for a vapor or vacuum system may be taken into a dry return through a steam trap.

Note 5—Pitch of mains should be not less than ¼ inch in 10 feet; on horizontal branches to radiators and risers should pitch at least ½ inch in 10 feet.

Vacuum Heating System with Pump

The vacuum heating system employing a pump is very similar to the vapor system, except that the receiver above the water line is omitted. A vacuum pump located below the water line receives all condensate, forces it back into the boiler, and at the same time eliminates air from the system. The pump creates and maintains a vacuum on the return line. Each radiator is supplied with an inlet valve on one end and a trap on the opposite end. Vacuum heating systems are generally used on large installations.

The diagram below shows a typical vacuum heating system installation with pump.



VACUUM HEATING SYSTEM WITH PUMP

Chart No. 8—Determination of Correct Sizes of Riser and Main

Vacuum Heating System with Pump

Care must be used in selecting the proper size and arrangement of piping in installations of this type. This chart shows the correct pipe sizes for a vacuum heating system with pump where equivalent length of run from boiler or source of supply to the farthest radiator does not exceed 600 feet. The capacities in square feet of equivalent radiation for supply mains are shown in columns B to G inclusive opposite the correct pipe sizes for the various conditions encountered.

Pipe Size In.	Equivalent Length of Pipe from Boiler to Farthest Radiator, Including Main and Riser. (See *Note 4.*) Supply Main Dripped and Branches to Risers Dripped—Steam and Condensate flowing in same direction. Based on 4 oz. Total Pressure Drop**						Maximum Capacities		Pipe Size Inches		Return Mains and Risers					
	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.	Supply Risers Up-Feed	Branches to Supply Risers and Radiators Not Dripped	Riser	Main	100 Ft.	200 Ft.	300 Ft.	400 Ft.	500 Ft.	600 Ft.
A	B	C	D	E	F	G	H	I*	J	K	L	M	N	O	P	Q
¾	...	..	..	..	..	..	..	..	..	¾	800	568	462	400	358	326
1	111	79	65	56	49	46	56	26	¾	1	1400	994	810	700	626	570
1¼	245	173	141	122	110	100	122	58	1	1¼	2400	1704	1387	1200	1073	976
1½	380	269	220	190	165	155	190	95	1¼	1½	3800	2696	2195	1900	1698	1547
2	771	546	446	386	345	315	386	195	1½	2	8000	5680	4622	4000	3575	3256
2½	1270	898	734	635	568	518	635	395	2	2½	13,400	9510	7745	6700	5990	5453
3	2326	1645	1342	1163	1040	948	1129	700	2½	3	21,400	15,190	12,360	10,700	9565	8710
3½	3474	2457	2006	1737	1552	1419	1548	1150	3	3½	32,000	22,710	18,490	16,000	14,300	13,020
4	4914	3475	2828	2457	2196	2011	2042	1700	3½	4	44,000	31,220	25,430	22,000	19,660	17,910
5	9092	6429	5250	4546	4062	3712	....	3150								
6	14,924	10,553	8618	7462	6669	6094	....	....								
8	31,066	21,967	17,935	15,533	13,880	12,682	....	....								
10	56,689	40,085	32,730	28,345	25,334	23,144	....	....								
12	90,985	64,336	52,530	45,492	40,660	37,145	....	....								

Different makes of supply and return valves, steam traps and other specialties vary as to capacity, therefore use size as recommended for any particular make. Vertical connection to be of same size as valve and trap used. Return horizontal runout to be no less than ¾ in.

*Radiator branches more than 8 feet in length should be one size larger than shown in Column I.

Notes—Vacuum Heating System with Pump

**It is not generally considered good practice to greatly exceed 1 ounce drop in pressure in each 100 feet equivalent length of run nor to exceed 1 pound total pressure drop in any system.

Note 1—These tables apply where pipes are properly reamed. No allowances for defective material or workmanship have been made.

Note 2—Capacities based on ¼ pound condensation per square foot per hour equivalent radiation and on actual diameter of standard pipe.

Note 3—Extra length to be added to straight run of pipe, for various fittings and valves to determine equivalent length. See chart 9, below.

Note 4—Mains are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiators supplied by the main.

Determine equivalent length of run, then use figures in corresponding Column (B to G) for sizing the entire run.

Supply risers are to be proportioned according to the equivalent length of run from the boiler or source of supply to the farthest radiator on each riser. Determine the distance to the farthest radiator, then use figures in that corresponding Column (B to G) for sizing each riser; provided the amount of radiation for that riser does not exceed amounts shown in Column H. Where riser capacities are found to be in excess of amounts shown in Column H, step up to necessary size indicated in that column.

Note 5—Return mains and risers are to be proportioned according to the equivalent distance in feet, from farthest radiator to the vacuum pump; using capacities in that corresponding column (L to Q) for sizing entire return riser (Column J) and return main (Column K). The return pipe sizes are conservative and are subject to revision, upon the completion of pending research investigations.

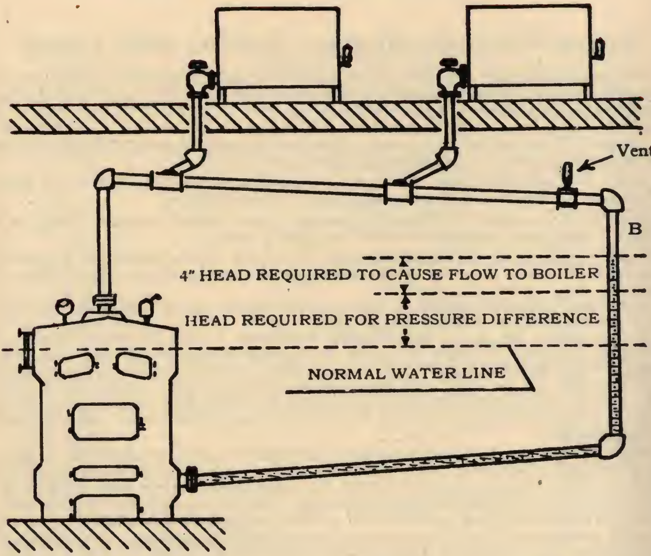
Note 6—Where it is necessary to drip a supply main, supply riser or branch to a supply riser, same should be dripped separately through a steam trap into vacuum return. Never drip a supply riser into a vacuum return except through a steam trap.

Note 7—Lift fittings. See page 356.

Chart No. 9

Length in Feet of Pipe to be Added to Actual Length of Run to Obtain Equivalent Length

Size of Pipe	St'd Elbow	Side Outlet Tee	Gate Valve	Globe Valve	Angle Valve
	Length in Feet to be Added in Run				
2"	5	16	2	18	9
2½"	7	20	3	25	12
3"	10	26	3	33	16
4"	14	35	5	45	22
5"	18	44	7	57	28
6"	22	50	9	70	32
7"	26	55	10	82	37
8"	31	63	12	94	42
9"	35	69	13	105	47
10"	39	76	15	118	52
12"	47	90	18	140	63
14"	53	105	20	160	72



Causes and Prevention of Water Line Trouble

A frequent cause of trouble in a steam system is insufficient distance between the water line in the boiler and the low point of the main. The end of the supply main should be at least 18 inches above the normal water line of the boiler and in vapor systems 24 to 30 inches is recommended.

The diagram above represents a typical system. Assume that two pounds gauge pressure is developed at the boiler. If there were no pressure loss in the piping, the pressure would be two pounds at end of main "B", as well as at the boiler, and the water level at these points would be the same. But in all steam systems there is a loss in pressure between the boiler and the end of the supply main, due to friction, heat loss in the piping, and steam consumed by radiators. This loss results in a

lower pressure at "B" than in the boiler. The condensation will therefore build up in the piping above the water level in the boiler until it reaches a height where the difference in "head," or level, is sufficient to compensate for the difference in pressure existing in the boiler and at point "B". A difference in level of approximately 28 inches will compensate for 1 pound difference in pressure (1.732 inches per ounce). Therefore, the height the water will rise at any point in the piping system will be equal to the difference in pressure in pounds multiplied by 28 inches (or ounces multiplied by 1.732 inches.)

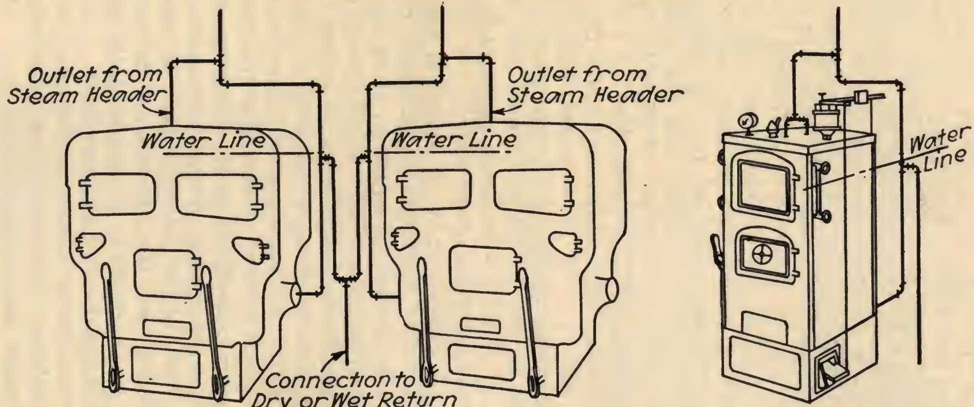
In the typical example, assume that the pressure at the boiler is 2 pounds and that at "B" it is $1\frac{1}{2}$ pounds. The pressure difference at "B" will then be $2-1\frac{1}{2}=\frac{1}{2}$ pound. The resulting head which will build up at this point will then be $\frac{1}{2}$ x 28″ = 14 inches. This head of 14 inches merely compensates for the pressure difference at the boiler and at end of main or point "B", and an additional head of at least 4 inches is required to establish a flow of water back into the boiler.

Since a pressure difference of $\frac{1}{2}$ pound is not at all unusual and since this difference in pressure requires a water head of 14 inches to equalize, it is obviously important to have the end of the supply main or any drip points in a steam system at least 18 inches (14+4) above the normal water line of the boiler, otherwise, the end of the supply main or drip points may be flooded, and steam distribution to some of the radiators prevented.

In a vapor system, as there is no steam pressure in the returns (due to the closing of the thermostatic traps when steam strikes them) the difference between the pressure in the boiler and the pressure in the return at the end of the steam main is proportionately greater, and the water will build up to a higher level.

It is therefore advisable to have a difference of from 24 to 30 inches between the low end of the steam main and the normal water level in the boiler.

Hartford Return Connections as Applied to Two Boilers in a Battery, and as Applied to a Single Boiler



This method of connecting the return with the boiler eliminates the necessity for check valves, and is recommended by the insurance companies. It is rapidly becoming standard practice.

Note: The top of the connection from wet return into the equalizer and drip pipe should be one inch below the water line of the boiler.

Recommended Steam Connections

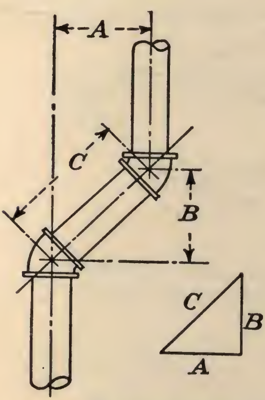
Radiators—Risers—Mains

For a smoothly operating steam system, the connections between mains, return and equipment are extremely important. The following diagrams will be of value in helping to make the systems work smoothly.

Angle Fittings

To find pipe measurements when angle and one side are known.

To find center of hole and length of pipe—center to center—when angle of fitting (Col. 1) is known, and one side or offset.

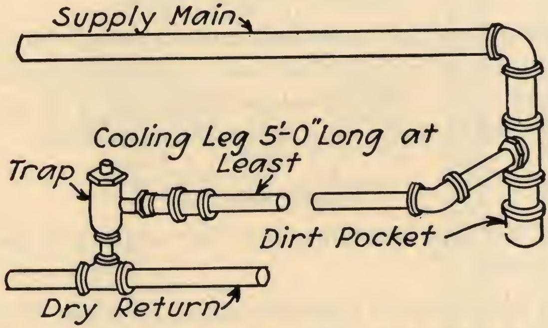


Fitting Used—Degrees	Length of "B" When A=1.	Length of "A" When B=1.	Length of "C" When offset=1.
67½	0.4142	2.414	1.0824
60	0.5773	1.732	1.1547
45	1.0000	1.000	1.4142
30	1.732	0.5773	2.0000
22½	2.414	0.4142	2.6131
11¼	5.027	0.1989	5.1258
5⅝	10.168	0.0983	10.2170

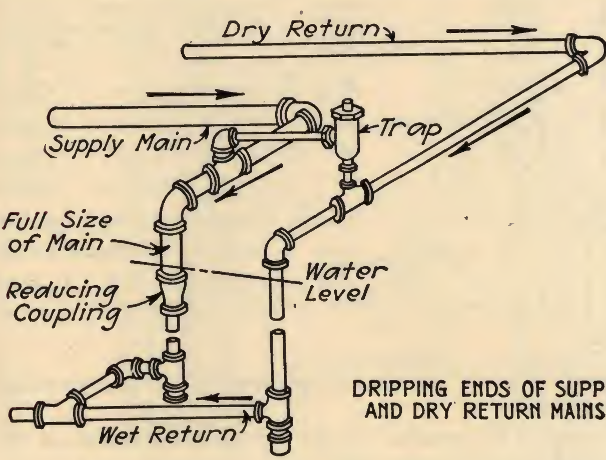
Example: With 30° fittings, how long must "C" be to give an offset (A) of 15 inches.

Solution: In last column, opposite the 30° fitting, length of "C" when offset is 1 is 2.00. Since offset is 15″, "C" equals 15 x 2 = 30 in.

Recommended Steam Connections (cont.)



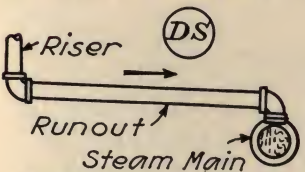
DRIPPING END OF MAIN INTO DRY RETURN



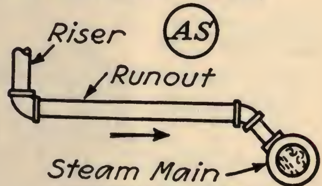
DRIPPING ENDS OF SUPPLY AND DRY RETURN MAINS

Recommended Steam Connections (cont.)

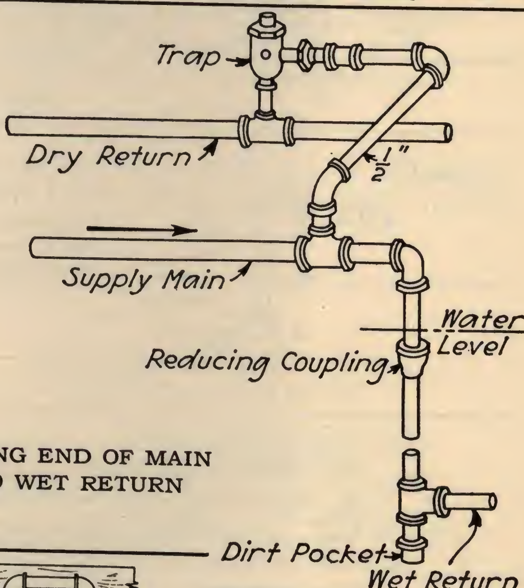
TAKING BRANCH FROM STEAM MAIN



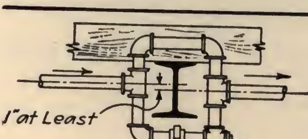
ACCEPTABLE METHOD
Condensate Hampers Steam Flow



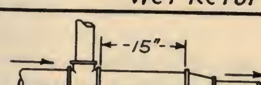
PREFERRED METHOD
Condensate does not Hamper Steam Flow



DRIPPING END OF MAIN INTO WET RETURN

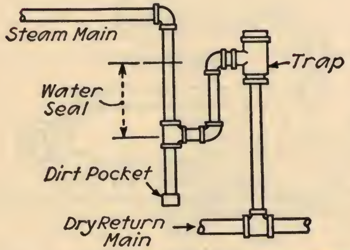


Looping Main Around Beam

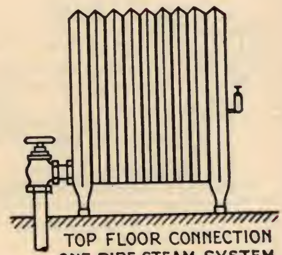


Practical Method of Reducing Size of Main

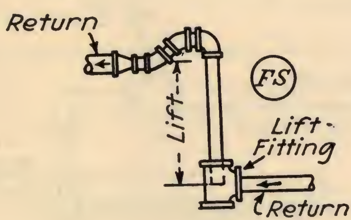
Recommended Steam Connections (cont.)



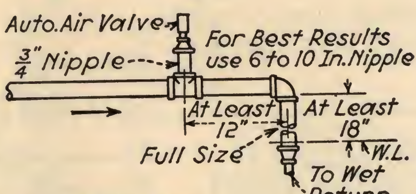
Drip connection with water seal from steam main to dry return.



TOP FLOOR CONNECTION
ONE PIPE STEAM SYSTEM

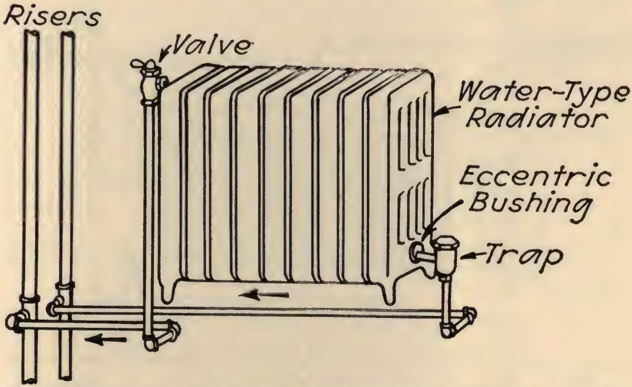


(Left) Detail of lift fitting and connections in return line to vacuum pump.



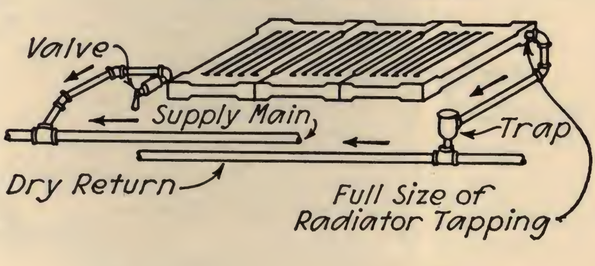
Method of venting end of steam main. Note location of automatic air valve.

Recommended Steam Connections (cont.)

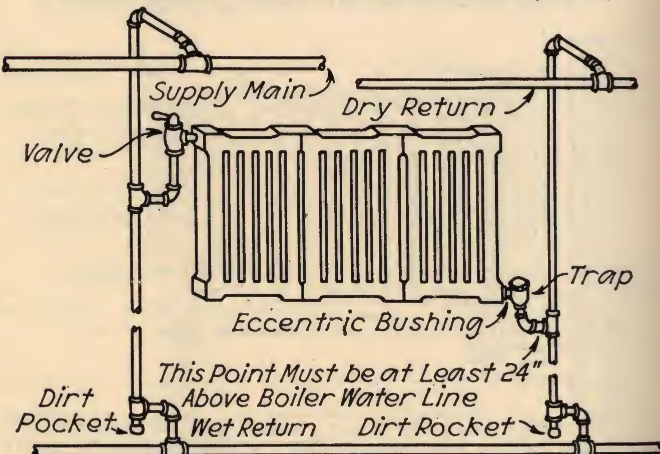


TOP AND BOTTOM OPPOSITE END RADIATOR CONNECTIONS FROM UP OR DOWN FEED RISERS

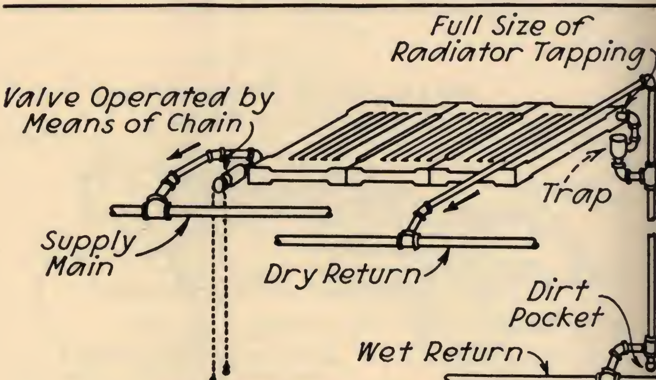
METHOD OF CONNECTING CEILING RADIATORS



Recommended Steam Connections (cont.)



CONNECTIONS TO RADIATOR HUNG ON WALL
BELOW DRY RETURN



METHOD OF CONNECTING
CEILING RADIATORS

Recommended Steam Connections (cont.)

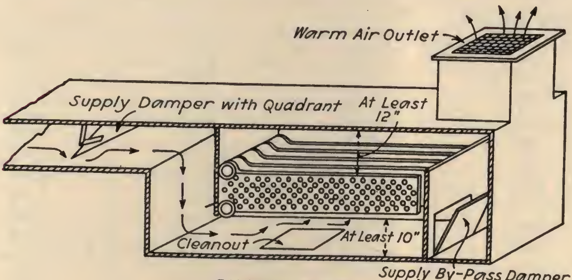


DIAGRAM NO. 15

TYPICAL ARRANGEMENT OF INDIRECT CASING WITH CLEANOUT AND DAMPERS

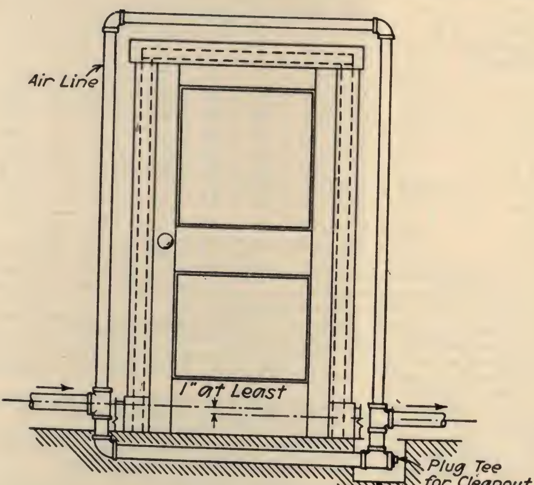


DIAGRAM NO. 16

LOOPING AIR LINE AROUND OPENING TO PREVENT AIR BINDING WHEN RETURN DROPS BELOW OPENING

Chart No. 10 Expansion of Pipe in Inches per 100 Feet

A	B	C	D
Temperature Rise Deg. Fahr.	Wrought Iron or Steel	Cast Iron	Copper or Brass
0	0.00	0.00	0.00
10	0.08	0.05	0.13
20	0.15	0.10	0.25
30	0.23	0.15	0.35
40	0.30	0.25	0.45
50	0.38	0.36	0.57
100	0.76	0.72	1.14
150	1.15	1.10	1.75
200	1.57	1.50	2.38
250	1.99	1.90	3.02
300	2.47	2.35	3.74
350	2.94	2.80	4.45
400	3.46	3.30	5.24

Chart No. 11 Length of Expansion Offsets or Bends for Proper Expansion of Pipe

E Total Expansion in Inches*	Feet of Pipe and Offset or U-Bend for Different Diameters of Pipe									
	F	G	H	I	J	K	L	M	N	O
	2″	3″	4″	5″	6″	8″	10″	12″	14″	16″
1	11	13	15	17	19	21	23	25	27	30
2	15	18	21	23	26	29	32	35	38	42
3	18	22	26	29	32	36	40	43	48	52
4	21	26	30	34	37	42	47	50	56	58
5	24	30	34	38	41	47	53	57	63	65
6	27	33	37	41	45	52	58	63	69	71
7	30	36	40	44	48	56	62	68	74	..
8	32	39	43	47	52	60	66	72	..	..

*This column shows the total expansion the offset will take care of without a cold strain. In general these amounts can be increased 40 per cent which increase can be taken up in cold strain of the pipe on being made up.

The total length of pipe in the expansion member should be the same whether in the form of a single right-angle offset or double offset or U-Bend.

The lengths of arms figured for 12,000 lb. per square inch tension for wrought iron pipe. If steel pipe is used this is good for 16,000 lb. per inch so that the arm will take care of ⅓ more expansion.

Example: (A) How much expansion will take place in 400 feet of steel pipe if it is installed at 12 above zero, and steam at 212° is passed through it?

Solution: Temperature range = 212 — 12 = 200. Find 200 degrees in column "A" above. Opposite, in Column "B" appears 1.57 inches—the expansion per hundred feet. In 400 feet, the expansion is 4 x 1.57 = 6.28 inches.

Example (B) If the pipe is 3″ diameter, what length of offset is required? In column "E" find the expansion equal to, or next greater than, the required expansion; in this case, 7 inches. Opposite, in column "G", appears 36 feet—the length required to form an offset that will take care of the expansion without cold strain in the pipe.

Chart No. 12 Square Feet of Surface per Lineal Foot of Pipe

On all lengths over 1 ft., fractions less than tenths are added to or dropped.

L'gth of pipe in ft.	Nominal Size of Standard Weight Pipe											
	¾"	1"	1¼"	1½"	2"	2½"	3"	4"	5"	6"	7"	8"
	Square Feet of Surface											
1	.275	.346	.434	.494	.622	.753	.916	1.175	1.455	1.739	1.996	2.257
2	.5	.7	.9	1.	1.2	1.5	1.8	2.4	2.9	3.5	4.	4.5
3	.8	1.	1.3	1.5	1.9	2.3	2.7	3.5	4.4	5.2	6.	6.8
4	1.1	1.4	1.7	2.	2.5	3.	3.6	4.7	5.8	7.	8.	9.
5	1.4	1.7	2.2	2.4	3.1	3.8	4.6	5.8	7.3	7.7	10.	11.3
6	1.6	2.1	2.6	2.9	3.7	4.5	5.5	7.	8.7	10.5	12.	13.5
7	1.9	2.4	3.	3.4	4.4	5.3	6.4	8.2	10.2	12.1	14.	15.8
8	2.2	2.8	3.5	3.9	5.	6.	7.3	9.4	11.6	13.9	16.	18.
9	2.5	3.1	3.9	4.4	5.6	6.8	8.2	10.6	13.1	15.7	18.	20.3
10	2.7	3.5	4.3	4.9	6.2	7.5	9.1	11.8	14.6	17.4	20.	22.6
11	3.	3.8	4.8	5.4	6.8	8.3	10.	12.9	16.	19.1	22.	24.9
12	3.3	4.1	5.2	5.9	7.5	9.	11.	14.1	17.4	20.9	24.	27.1
13	3.6	4.5	5.6	6.4	8.1	9.8	11.9	15.3	18.9	22.6	26.	29.4
14	3.8	4.8	6.1	6.9	8.7	10.5	12.8	16.5	20.3	24.3	28.	31.6
15	4.1	5.2	6.5	7.4	9.3	11.3	13.7	17.6	21.8	26.1	30.	33.9
16	4.4	5.5	6.9	7.9	10.	12.	14.6	18.8	23.2	27.8	32.	36.1
17	4.7	5.9	7.4	8.4	10.6	12.8	15.5	20.	24.7	29.5	34.	38.4
18	5.	6.2	7.8	8.9	11.2	13.5	16.5	21.2	26.2	31.3	36.	40.6
19	5.2	6.6	8.3	9.4	11.8	14.3	17.4	22.3	27.6	33.1	38.	42.9
20	5.5	6.9	8.7	9.9	12.5	15.	18.3	23.5	29.1	34.8	40.	45.2
21	5.8	7.3	9.1	10.4	13.	15.8	19.2	24.7	30.5	36.5	42.	47.4
22	6.	7.6	9.6	10.9	13.7	16.5	20.2	25.9	32.	38.3	44.	49.7
23	6.3	8.	10.	11.3	14.3	17.3	21.1	27.	33.5	40.	46.	52.
24	6.6	8.3	10.4	11.9	14.9	18.	22.	28.2	34.9	41.7	48.	54.2
25	6.9	8.6	10.9	12.3	15.6	18.8	22.9	29.3	36.3	43.5	50.	56.4
30	8.3	10.4	13.	14.8	18.7	22.5	27.5	35.3	43.6	52.1	60.	67.7
35	9.6	12.1	15.2	17.3	21.8	26.3	32.	41.1	50.9	60.8	70.	79.
40	11.	13.8	17.4	19.8	24.9	30.1	36.6	47.	58.2	69.5	80.	90.2
45	12.4	15.6	19.5	22.2	28.	33.8	41.2	52.9	65.5	78.2	90.	101.6
50	13.8	17.3	21.7	24.7	31.1	37.6	45.8	58.7	72.7	87.	100.	112.8

Chart No. 13 Showing Losses From Horizontal Bare Iron Pipes Containing Hot Water for 24 Hours a Day. Per 100 lineal feet of pipe per month of 30 days.

Pipe Size	Temperatures—Hot Water											
	120 Deg. Fahr.			150 Deg. Fahr.			180 Deg. Fahr.			210 Deg. Fahr.		
	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.
½″	0 53	215	0.543	0.90	363	0.573	1.32	526	0.605	1.77	707	0.638
¾″	0.65	261	0.660	1.09	437	0.690	1.58	635	0.729	2.11	845	0.762
1″	0.78	313	0.791	1.31	525	0.829	1.91	763	0.878	2.55	1020	0.920
1¼″	0.97	388	0.979	1.61	646	1.02	2.36	947	1.087	3.19	1275	1.15
1½″	1.08	432	1.09	1.82	728	1.15	2.65	1060	1.220	3.57	1430	1.29
2″	1.32	530	1.34	2.21	886	1.40	3.24	1297	1.491	4.37	1750	1.58
2½″	1.56	625	1.58	2.64	1056	1.67	3.86	1545	1.778	5.18	2075	1.87
3″	1.86	744	1.88	3.15	1260	1.99	4.56	1824	2.100	6.12	2460	2.22
3½″	2.11	843	2.13	3.54	1418	2.24	5.18	2070	2.380	6.95	2780	2.51
4″	2.33	934	2.36	3.95	1580	2.50	5.78	2305	2.650	7.70	3080	2.78
4½″	2.57	1030	2.60	4.35	1740	2.75	6.35	2540	2.920	8.53	3420	3.08
5″	2.84	1135	2.87	4.77	1910	3.02	6.95	2780	3.200	9.36	3750	3.38
6″	3.35	1342	3.39	5.62	2250	3.56	8.20	3280	3.775	11.10	4450	4.01
7″	3.83	1533	3.87	6.40	2570	4.06	9.40	3760	4.325	12.70	5080	4.58
8″	4.27	1710	4.32	7.20	2880	4.55	11.00	4398	5.050	14.24	5700	5.14
9″	4.75	1900	4.80	8.00	3200	5.05	11.62	4650	5.350	15.80	6330	5.71
10″	5.26	2100	5.32	8.86	3550	5.61	12.68	5065	5.925	17.55	7030	6.34
12″	6.18	2475	6.25	10.46	4190	6.62	15.00	6000	6.995	20.65	8270	7.46
14″	6.74	2700	6.82	11.40	4570	7.22	16.60	6635	7.625	22.40	8980	8.10
16″	7.66	3065	7.74	12.95	5190	8.20	18.82	7525	8.650	25.50	10,200	9.20
18″	8.58	3440	8.68	14.53	5820	9.20	21.00	8400	9.650	28.60	11,450	10.33

In these tables coal has been figured at $4.00 per ton of 2000 lb.—13,000 B. T. U. per lb. of coal—labor, boiler room expense, etc., taken at $1.00 per ton, making total value of coal fired $5.00 per ton. Boiler efficiency taken at 70 per cent. Air temperature 70 deg. fahr. Experimental data obtained at the *Mellon Institute*.

Chart No. 14 Showing Losses From Horizontal Bare Iron Pipes Containing Steam for 24 Hours a Day. Per 100 lineal feet of pipe per month of 30 days.

Pipe Size	Gauge Pressures								
	10 Lbs. 239.4 Deg. Fahr.			80 Lbs. 324 Deg. Fahr.			120 Lbs. 350 Deg. Fahr.		
	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.	Dollars Loss	Lbs. Coal	B.T.U. per Lineal Ft. per Deg. Fahr. Diff. per Hr.
½″	2.24	897	0.670	3.92	1566	0.779	4.51	1805	0.815
¾″	2.70	1083	0.809	4.74	1895	0.943	5.48	2190	0.990
1″	3.26	1305	0.973	5.72	2290	1.14	6.25	2601	1.18
1¼″	4.00	1610	1.20	7.14	2860	1.42	8.18	3280	1.48
1½″	4.54	1818	1.35	7.98	3190	1.58	9.28	3710	1.67
2″	5.36	2142	1.60	9.78	3910	1.94	11.37	4549	2.05
2½″	6.65	2660	1.98	11.66	4660	2.32	13.66	5460	2.46
3″	8.24	3292	2.46	13.88	5550	2.76	16.14	6450	2.91
3½″	8.89	3554	2.65	15.82	6325	3.14	18.31	7322	3.30
4″	9.87	3950	2.95	17.70	7075	3.52	25.50	8200	3.70
4½″	10.94	4370	3.26	19.48	7790	3.87	22.60	9025	4.07
5″	11.97	4790	3.57	21.25	8500	4.23	24.62	9850	4.45
6″	14.21	5680	4.24	25.30	10,110	5.02	29.30	11,720	5.29
7″	16.18	6470	4.82	29.10	11,640	5.78	33.70	13,480	6.09
8″	18.25	7300	5.45	32.60	13,030	6.45	37.65	15,050	6.84
9″	20.35	8130	6.07	36.25	14,500	7.21	42.10	16,840	7.60
10″	22.05	8820	6.58	40.20	16,100	8.01	46.70	18,690	8.44
12″	26.44	10,580	7.89	47.40	18,950	9.42	55.40	22,120	10.00
14″	28.90	11,560	8.62	52.00	20,800	10.34	60.50	24,200	10.92
16″	32.80	13,120	9.79	58.76	23,500	11.70	68.40	27,320	12.34
18″	36.10	14,460	10.80	65.40	26,150	13.00	76.50	30,570	13.80

In these tables coal has been figured at $4.00 per ton of 2000 lbs.—13,000 B.T.U. per lb. of coal—labor, boiler room expense, etc., taken at $1.00 per ton, making total value of coal fired $5.00 per ton. Boiler efficiency taken at 70 per cent. Air temperature 70 deg. fahr. Experimental data obtained at the *Mellon Institute*.

Domestic Hot Water Heating

There are four distinct items that should be considered in the hot water supply for a building—first, the amount of water to be heated; second, the temperature rise; third, the rate at which it is to be heated; and, fourth, the equipment used for heating. The amount of water to be heated must be calculated from the charts below. The equipment used may be an instantaneous gas heater or a storage tank system. Where a continuous flow of hot water is required, the instantaneous heater can be used. Where a large flow of hot water is necessary at any one time, the storage system should be used. Where large amounts of hot water are to be used, such as a group of shower baths, large groups of fixtures, or swimming pools, a steam water heater makes an ideal piece of equipment.

Chart No. 15 Showing Flow in Gallons per Minute Delivered by Ordinary Plumbing Fixtures.

Fixture	Fair Flow	Good Flow	Excellent Flow
	GALLONS PER MIN.		
Kitchen Sink Bibbs	2	4	6
Pantry Sink–High Goose Neck Bibbs	2	2	3
Pantry Sink–Large Plain Bibbs	4	6	8
Vegetable Sink Bibbs	2	4	6
Laundry Tray Bibbs	4	6	8
Slop Sink Bibbs	3	4	6
Lavatory Basin Bibbs	2	3	4
Bathtub Bibbs	3	4	6
Shampoo Spray	½	1	2
Shower Baths			
5-inch rain heads	2	3	4
6½-inch rain heads	2	3	5
8-inch rain heads	4	6	8
8-inch Tubular heads	6	8	10
Needle Baths	20	30	40
Manicure Tables	1	1½	2

Chart No. 16 Showing Gallons of Hot Water Used per Apartment in a Typical Apartment Building.

Fixture	Gallons Per Min. Good Flow	Times Used	Minutes Used	Gallons Used
Lavatory	3	4	1	12
Tub	4	1	4	16
Sink	4	1	½	1½
Trays	3	1	2	6
			Total	35½

How To Determine Tank Capacities and Fuel Consumption for a Given Quantity of Hot Water Supply

EXAMPLE

(a) What capacity tank will be required to store sufficient hot water for 5 bath tubs, 5 lavatories and 5 kitchen sinks?

(b) How many cubic feet of gas will be consumed in heating this water, if it is raised from 40 degrees to 120 degrees?

SOLUTION (a)

5 lavatories	5 × 3 = 15 gallons
5 tubs will use per minute	5 × 4 = 20 gallons
5 kitchen sinks	5 × 4 = 20 gallons

The storage capacity should equal the total amount of water used in one hour during the heaviest demand or the peak load period.

Referring to chart No. 16, page 364.

Fixture	Gallons used per minute	Times used per hour	Minutes used	Gallons used per hour
5 Lavatories	15	4	1	60
5 Tubs	20	1	4	80
5 Sinks	20	1	½	10

Total Gallons 150

The tank capacity required would be 150 Gallons.

SOLUTION (b)

To raise 150 gallons of water from 40 degrees to 120 degrees, a temperature rise of 80 degrees. Change gallons to pounds—150 gallons × 8⅓ pounds = 1250 pounds.

One B. T. U. will raise 1 pound of water one degree—1250 pounds × 1 B. T. U. × 80 degrees = 100,000 B. T. U.

Gas Burning Domestic Hot Water Heaters are about 80% efficient. Manufactured gas has 550 B. T. U. per cubic foot—80% of this is available.

550 × 80% = 440 B. T. U. per cubic foot of gas.

100,000 B. T. U. required to heat water divided by 440 available B. T. U. in gas equals 245 cubic feet.

Answer for solution (b) is 245 cubic feet of gas per hour.

See pages 154-155 for sizes and ratings of coal fired Hot Water Supply Boilers.

Typical Problem of Determining Size of Boiler, and Number of Feet of Pipe Coil Required for a Hot Water Installation in Connection with Swimming Pool

The increasing number of swimming pools being installed is enlarging a field of heating well worth cultivation. The problems involved in determining the size of boiler and the number of feet of pipe coil required, are simple, and will be fully understood from the specimen problem quoted below. The heat content of the coal should be varied to conform to the fuel used in your territory.

Example: (a) How many square feet of grate will be necessary to heat the water in a swimming pool the size of which is 60 ft. long, 30 ft. wide and 7 ft. deep using a water boiler? Water is to be raised from 40° to 80° in 24 hours. (b) How many feet of copper tube in a steam heater?

(a) Solution:

Contents of pool = 60 x 30 x 7 = 12600 cu. ft.

Water to be raised in 1 hr. = 12600 ÷ 24 = 525 cu. ft.

Lbs. of water to be heated = 525 cu. ft. x 62.42 lbs. = 32760 lbs.

Rise of temperature of water in pool = 40 degrees

B. T. U. necessary per hour = 32760 x 40 = 1310400

Coal necessary with 8333 B. T. U. per lb. available, 1310400 ÷ 8333 = 157.251 lbs.

8 lbs. of coal per sq. ft. of grate = 157.25 ÷ 8 = 19.65 sq. ft.

The answer to this question, then, would be to install boilers having 19.6 sq. ft. of grate. Page 73 of the National Heating Guide shows a National Imperial Boiler No. W-942, which can be used for this installation.

(b) Solution:

Temperature of steam........220°
Mean temperature of water... 60°

Temperature difference.......160° between steam and water.

1 sq. ft. of copper pipe condenses 50 lbs. of steam per hour under above conditions.

Amount of coal burned per hour, 157 lbs.

157 lbs. coal will evaporate 1310400÷1000=1310 lbs. steam which, if divided by 50 lbs.=

*26.2 sq. ft. of copper which is equivalent to:
56 ft. of 1½″ copper pipe—or
65 ft. of 1¼″ copper pipe—or
79 ft. of 1″ copper pipe—or
100 ft. of ¾″ copper pipe.

*1 sq. ft. copper at 160° Temperature difference transmits 50,000 B. T. U. per hour; 1,310,400÷50,000=26.2 sq. ft. of copper surface required.

Applying Taco Indirect Heater to Swimming Pool Installations

INDIRECT heaters are suitable for this service and when selecting them it should be remembered that Taco heaters are rated in gallons of water heated from 50 to 150 degrees in three hours when installed below the water line of a steam boiler. When used with live steam at two to five pounds pressure for heating water from 40 to 80 degrees F., as in the problem stated above, size of Taco should be selected as follows:

First, determine the number of square feet of copper tubing required from the above formula. Second, multiply this by 40 to secure the rating of the proper size of Taco indirect heater to use. Example: from the above, 26 sq. ft. times 40 equals 1040 gallons. A No. 20 Super Taco rated at 1000 gallons should be selected if the heater is to be installed in a vertical position, or a Taco No. 6 rated at 960 gallons if a horizontal heater is desired.

How to Select and Install Taco Heaters

Size of Storage Tank. Apartments having three to five rooms, and the usual private residences, require a storage capacity for domestic hot water of 30 gallons for each family or bath.

Tank size must be increased to provide for kitchen and laundry use and waste when there are a number of servants. For such an installation, whether in detached houses or apartments, 50 or more gallons storage capacity should be allowed per bath with a minimum storage of 100 gallons.

When considering the rated capacities of Taco heaters, whether operated under the standard conditions with coal-fired boilers or under intermittent firing conditions as with an oil burner and Taco-Abbott system, it should be understood that the rated capacities, as stated, were obtained from tests when operating under favorable conditions. This means with heater properly piped, the storage tank favorably located, and—in the case of coal-fired ratings—with the boiler steaming.

It is good practice to allow a margin when selecting Tacos of the proper size, to provide for loss of efficiency due to fouling. Future increased demands for hot water and unusual requirements demanded by guests, should also be considered. A larger size Taco is always a good

Taco Heaters (continued)

investment, particularly in mild weather when the boiler fires may be banked for hours at a time.

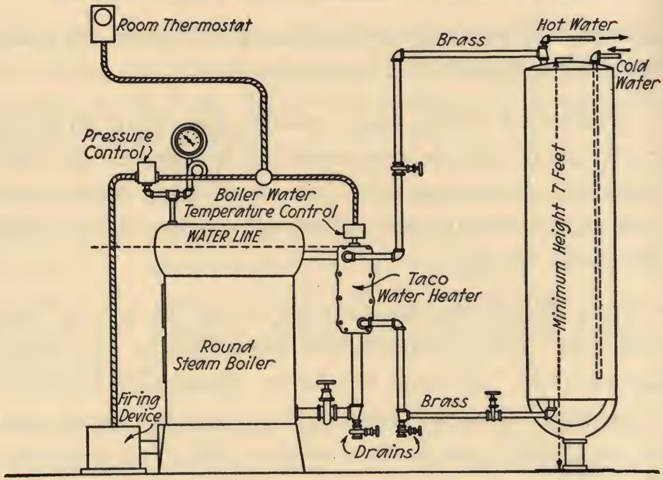
Horizontal storage tanks smaller than 18 or 20 inches in diameter, are not recommended because of the difficulty of preventing the hot and cold water from mixing, especially when large quantities of hot water are being drawn.

Pipe Sizes. Pipe sizes should be the full size of Taco openings. This is particularly important in the piping between the Taco and the boiler. Brass pipe is recommended for domestic water connections and where used it may usually be one size smaller than Taco tappings. See table.

Valves and Drains. The installation of the valves and drains shown in Figures AH and BH is necessary to permit flushing out the shell and coil of the heater at regular intervals.

Losses by Radiation. Radiation losses should be kept at a minimum and proper insulation of the Taco and its piping connections and the storage tank, is urged. This is particularly important in connection with the Taco-Abbott system where the heating boiler is operated during the summer months for domestic hot water supply only.

Fig. AH—Indirect Heater connected to a vertical tank.



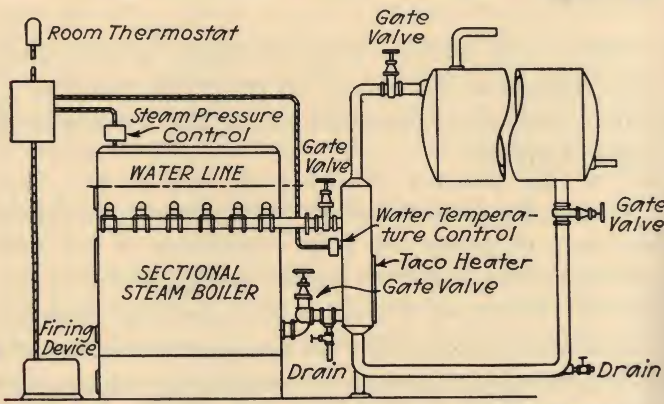


Fig. BH Indirect Heater connected to a horizontal tank. Top of tank should be at least 3′ above water line.

Table Showing Sizes and Data
Taco Indirect Heaters

**Tank capacity, gallons	30–40	40–60	66	85	100	120	140	150	180	220	250	295	365	420	450	500	525	575	720	865	1000
TACO Size No..........	1-A	2	2-A	3 or 7	3 or 7	3 or 7	9 or 4	9 or 4	10 or 4	10	12 or 5	12 or 5	20	20	20	25 or 6	25 or 6	25	35	35	50
Usual number of families	1	1	1–2	2–3	3	4	4–5	4–5	5–6	7	8	9–10	12	14	15	16	17	19	24	27	40
*Boiler connection, in...	1¼	1¼	1½	2	2	2	2	2	2	2	2½	2½	3	3	3	3	3	3	4	4	4
Tank connection, in.	¾	¾	1	1	1¼	1¼	1¼	1¼	1½	1½	1½	1½	2	2	2	2	2	2	3	3	3

*Brass piping recommended for domestic water connections. **With storage tank of proper size. See "Size of Storage Tank," Page 368.

Heating and Piping Contractors National Association Engineering Standards consider one gallon of storage tank capacity to be equivalent to one-half square foot of radiation when a submerged heater is used with a storage tank.

Minimum Allowable Sizes of Safety Valves for Steam Heating Boilers

Safety Valves furnished in National Boilers conform to the A. S. M. E. code. For replacements, sizes may be determined from this table.

Safety Valve

Diameter Inches	Area Sq. In.	Discharge Capacity 1 lb. per Hour	Area of Grate Sq. Ft.
¼	0.0491	15	1
⅜	0.1104	30	1.5
½	0.1963	60	2
¾	0.4418	120	3
1	0.7854	230	4
1¼	1.2272	360	6.5
1½	1.7671	515	9
2	3.1416	920	14
2½	4.9087	1435	19
3	7.0686	2070	24
3½	9.6211	2810	29
4	12.5660	3675	34
4½	15.9040	4650	39

1—Capacity of safety valve based on 33⅓ per cent over pressure, valve set to relieve at 10 or 15 pounds per square inch.

Note—the foregoing table is based upon the following formulas:

Where grate area does not exceed 4 sq. ft.

$$\text{Diam. of safety valve, in.} = \frac{\text{Grate area (sq. ft.)}}{4}$$

Where grate area exceeds 4 sq. ft.

$$\text{Diam. of safety valve, in.} = \left[\frac{\text{Grate area (sq. ft.)}}{10}\right] + 0.6$$

If liquid or gaseous fuel is used, a grate area shall be assumed equal to that which would be required if coal were used for fuel.

Chimneys

Provisions of Underwriters Code

THE construction of chimneys should be in accordance with the National Board of Fire Underwriters' Chimney Code. Briefly summarized, the code provisions follow.

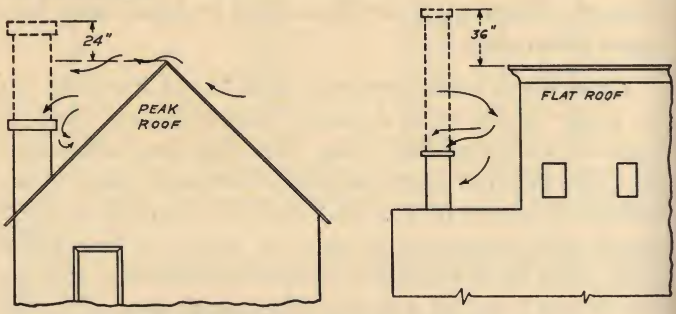
The construction, location, height and area of the chimney to which a heating boiler is connected affect the operation of the entire heating system. Most residence chimneys are built of brick and may be either lined or unlined, but in either case the *walls must be air-tight* and there should be *only one smoke opening* into the chimney. Cleanout, if provided, must be *absolutely air-tight* when closed.

The walls of brick chimneys shall be not less than 3¾ in. thick (width of a standard size brick)and shall be lined with fire-clay flue lining. Fire-clay flue linings shall be manufactured from suitable refractory clay, either natural or compounded, and shall be adapted to withstand high temperatures and the action of flue gases. They shall be of standard commercial thickness but not less than ¾ in. All fire-clay flue linings shall meet the standard specification of the *Eastern Clay Products Association*. The flue sections shall be set in special mortar, and shall have the joints struck smooth on the inside. The masonry shall be built around each section of lining as it is placed, and all spaces between masonry and linings shall be completely filled with mortar. No broken flue lining shall be used. Flue linings shall start at least

Chimneys (continued)

4 in. below the bottom of smoke-pipe intakes of flues, and shall be continued the entire heights of the flues and project at least 4 in. above chimney top to allow for a 2 in. projection of lining. The wash or splay shall be formed of a rich cement mortar. To improve the draft the wash surface should be concave wherever practical.

Flue lining may be omitted in brick chimneys, provided the walls of the chimneys are not less than 8 in. thick, and that the inner course shall be a refractory clay brick. All brickwork shall be laid in spread mortar, with all joints push-filled. Exposed joints both inside and outside shall be struck smooth. No plaster lining shall be permitted.



CHIMNEY TOP SHOULD ALWAYS EXTEND ABOVE THE HIGHEST PART OF ROOF AT LEAST 24 INCHES ON PEAK ROOF AND 36 INCHES ON FLAT ROOF

Chimneys shall extend at least 3 ft. above flat roofs and 2 ft. above the ridges of peak roofs when such flat roofs or peaks are within 30 ft. of the chimney. The chimney shall be high enough so that the wind from any direction shall not strike the top of the chimney from an angle above the horizontal. The chimney shall be properly capped with stone, terra cotta, concrete, cast iron,

Chimneys (continued)

or other approved material; but no such cap or coping shall decrease the flue area.

There shall be but one connection to the flue to which the boiler or furnace smoke-pipe is attached. The boiler or furnace smoke-pipe shall be thoroughly grouted into the chimney and shall not project beyond the inner surface of the flue lining.

The size or area of flue lining or of brick flue for warm-air furnaces depends on height of chimney and capacity of heating system. For chimneys not less than 35 ft. in height above grate line, the net internal dimensions of lining should be at least 7 x 11½ in. for a total leader pipe area up to 790 sq. in. Above 790 and up to 1000 sq. in. of leader pipe area the lining should be at least 11¼ x 11¼ in. inside. In case of brick flues not less than 35 ft. in height with no linings, the internal dimensions should be at least 8 x 12 in. up to 790 sq. in. of leader area, and at least 12 x 12 in. for leader capacities up to 1000 sq. in. Chimneys under 35 ft. in height are unsatisfactory in operation and hence should be avoided.

Smoke Test

The chimney flue shall be subjected to a smoke test by the mason contractor in the presence of the architect or his representative, after the mortar has thoroughly hardened, and must be *smoke tight*.

The method of conducting this test shall be as follows: With a good fire in the boiler or furnace, or in the base of the chimney, put about a square yard of tar paper on

Chimneys (continued)

the fire. As soon as smoke appears at the top of the chimney close the top of the flue with a piece of old carpet or wet newspapers held down by a weighted board. Keep the tar paper burning in the firepot for five minutes. The architect or his representative shall sign an acceptance in triplicate, stating that the chimney was tight under the above test, and shall give one copy to the mason contractor, one copy to the heating contractor and one copy to the owner.

Standard Dimensions of Fire Clay Flue Linings

Rectangular Flues

Outside Dimensions of Flue Linings Inches	Inside Dimensions of Flue Linings Inches	Inside Cross Sectional Area of Flue Linings Square Inches
7½ x 7½	6¼ x 6¼	39.06
8½ x 8½	7¼ x 7¼	52.56
8½ x 13	7 x 11½	80.5
8½ x 18	6¾ x 16¼	109.69
13 x 13	11¼ x 11¼	126.56
13 x 18	11¼ x 16¼	182.84
18 x 18	15¾ x 15¾	248.06
20 x 20	17¼ x 17¼	297.56
20 x 24	17 x 21	357.0
24 x 24	21 x 21	441.0

Round Flues

Outside diameter of Flue Linings Inches	Inside Diameter of Flue Linings Inches	Inside Cross Sectional Area of Flue Linings Square Inches
7¼	6	28.27
9½	8	50.26
11¾	10	78.54
14	12	113.0
17¼	15	176.7
20½	18	254.4
22¾	20	314.1
25⅛	22	380.13
27¼	24	452.3
31	27	572.5
34¼	30	706.8
37½	33	855.3
41	36	1017.9

Chimneys

Residence Chimney Dimensions Based on Total Volume of Building.

This table is provided for the use of the architect or builder, to enable him to determine a suitable size of chimney when designing residences—even before the specific boiler is selected.

Residence Volume Cu. Ft.	Maximum Requirement B.T.U./Hr.	Maximum Requirement Important—See Basis of Table		Rectangular Flue			Round Inside Diameter of Lining Inches	Height from Grate Feet
		Sq.Ft. *Steam	Sq.Ft. **Water	Inside Area Sq. In.	Inside Dimensions of Lining Inches	Outside Dimensions of Lining Inches		
12940	155000	647	1034	80.5	7 x 11½	8½ x 13	10	36
22120	265000	1106	1772	126.5	11¼ x 11¼	13 x 13	12	38
35800	430000	1790	2865	182.8	11¼ x 16¼	13 x 18	15	42
54000	660000	2750	4400	248.0	15¾ x 15¾	18 x 18	18	47
71600	860000	3580	5730	297.5	17¼ x 7¼	20 x 20	20	50

* Basis of Table

One Sq. Ft. *Steam Radiation* will heat 40 Cu. Ft.

Maximum B. T. U. requirement equals twice the direct radiator load (or its equivalent) multiplied by 240.

Maximum B. T. U. requirement will therefore be the volume multiplied by 240 divided by 20.

** Basis of Table

One Sq. Ft. *Water Radiation* will heat 25 Cu. Ft.

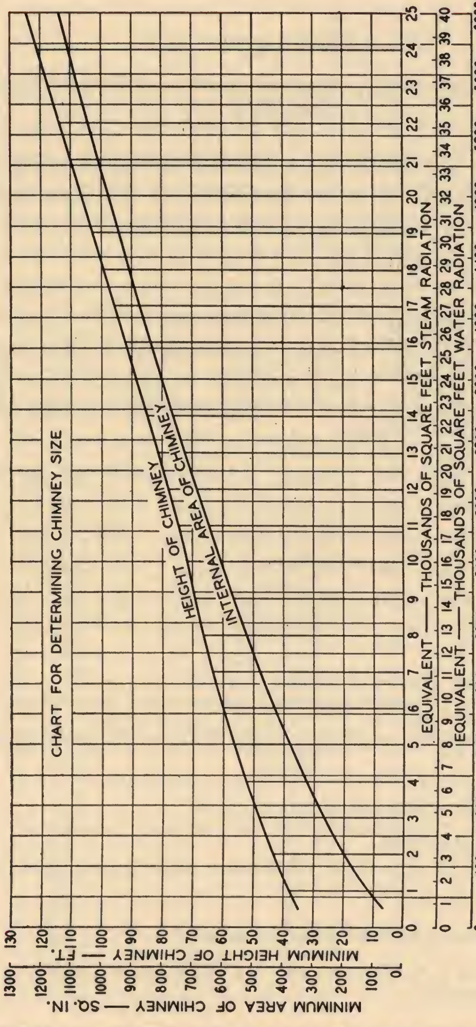
Maximum B. T. U. requirement equals twice the direct radiator load (or its equivalent) multiplied by 150.

Maximum B. T. U. requirement will therefore be the volume multiplied by 150 divided by 12.5.

Note

For residences having unusual auxiliary equipment:

Figure Maximum B. T. U. requirement. Use Chart No. 17, page 378, to determine chimney dimensions.



E – 3

Chart No. 17 is provided for the use of the architect or engineer, to enable him to determine a suitable size of chimney after ascertaining *all* heat demands of the building.

Chimneys

Determining Proper Chimney Size

THE chart shown was prepared by the Special Technical Committee of the Institute of Boiler and Radiator Manufacturers, and is part of the National Board of Fire Underwriters' "Ordinance for Construction of Chimneys."

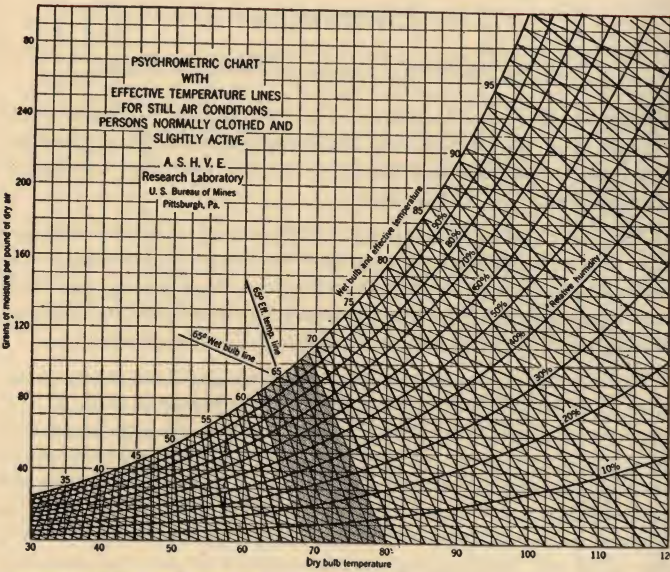
The chart shows the minimum inside area and height of chimney that should be provided for various total heat requirements—the chimney dimensions to be chosen *after* ascertaining the total maximum demands of whatever character that will be made on the boiler—including suitable allowance for pick-up load.

In using the chart, the total load in equivalent direct steam radiation, equivalent direct water radiation, or thousands of B. T. U's. per hour is found on the proper horizontal scale. Directly above find the intersection of the vertical line from this point with the curve showing the internal area of the chimney. On the area scale at the left on a line with this intersection, read the minimum internal area in square inches of the chimney. The intersection of the same vertical line with the "Height of Chimney" curve will give the minimum height of chimney, which is read on the "Minimum Height of Chimney" scale at left.

A typical example of the use of this chart follows:

Direct Steam Radiation	=	2,000 Sq. Ft. E. D. R.
Piping Load	=	500 " " "
Blast Heater Load	=	1,800 " " "
Blast Heater Piping Load	=	200 " " "
Hot Water Supply Load	=	1,000 " " "
Allowance for "pick-up" load	=	1,000 " " "
Total E. D. R. Requirement	=	6,500 " " "

Chimney Dimensions—Chart No. 17 = 450 Sq. Ins. x 62 Ft.



Psychrometric Chart No. 18 with Effective Temperature Lines for Still Air
Shaded Area Indicates the Comfort Zone

Temperature Lines for the Best Still Air Conditions for Persons Normally Clothed and Slightly Active

The diagram shows the best air conditions for persons normally clothed and slightly active. The shaded portions of this diagram indicate the ranges of temperature and wet bulb reading in which a normal person will feel comfortable. The dry bulb temperature reading can be obtained on the bottom scale. The wet bulb reading can be obtained on the upper curved scale. The relative humidity can be obtained on the super-imposed curves. This chart gives the relation of temperature and humidity for comfort to the average person who is normally clothed and is resting in still air. For the same degree of comfort for persons at work or in different air movements, other than still air, reference is made to the American Society of Heating and Ventilating Engineers Guide.

Greenhouse Heating Systems

Temperature Required, Steam Heating Systems, Hot Water Radiation, Location of Radiation, Air Circulation.

A glass structure for horticultural purposes, owing to the manner of its construction and the material employed, offers less resistance to the penetration of frost and cold winds than many other kinds of buildings and necessarily requires a proportionately greater amount, and a more even distribution, of heat.

The heating apparatus must be so arranged as to diffuse an even heat throughout every part of the house, and must be of sufficient heating power to increase the heat quickly in case of sudden changes in the weather, and so maintain the desired temperature during the night.

The temperatures usually required depend on the class of vegetation to be grown and are given in Table A.

Although the same tables, formulae and other data used to estimate the heating requirements of systems in the usual types of buildings are also applicable to greenhouse heating and although the same pumps, traps, regulators, valves and other devices and fittings are used in greenhouses as in other systems, there are many differences that must be kept in mind so that due allowance may be made in the specification of a heating plant.

For instance—the highest temperatures in greenhouses are required at night, whereas with most other systems the maximum temperatures are required in the day time.

Greenhouse fires are almost always banked during the day throughout the firing season, even in mid-winter when the sun is shining; this in marked contrast to prac-

Greenhouse Heating (continued)

tically all other types of heating systems where the fires are banked at night.

Greenhouse radiation is almost exclusively made up of piping. The temperature demands are almost always below 70 degrees and horizontal piping carries a higher coefficient of emission than the radiating surfaces used in other systems. Special care must, therefore, be given to the selection of the boiler; the demands on it will be higher than with other forms of radiation.

The Bonded Ratings of National Boilers can be safely used in selecting boilers for greenhouses. The additional demands are compensated for by the allowance included in the ratings for piping loss, always present in buildings other than greenhouses.

Long runs of pipe are used and expansion and contraction require more consideration than in house-heating work; piping must be tied up, anchored; installations must be flexible. Although expansion joints are no more desirable in greenhouse heating than elsewhere, expansion must be compensated for by "spring" of pipe and by swivel fitted joints, expansion joints being used where expansion may not be compensated otherwise. See tables on Page 360, for data on expansion of piping.

The height of the heating coils above the boiler affects the design and proportion of the heating mains. In many greenhouses the coils are not more than 1 ft. 6 in. above the top of boiler and the arrangement of the greenhouse doors necessitates some of the coils being much shorter than others. In this case special care is necessary to avoid short circuiting, or interference with the circulation of the water in the longer coils.

Greenhouse Heating (continued)

Table A. Usual Temperatures Required in Greenhouses

Kind of Vegetation	Temperature Required, Deg. Fahr.
Violets Camelias Azaleas Lettuce	40 to 45
Cool Palm Houses Carnations	50 to 55
General Purposes Roses Mushrooms	55 to 60
Forcing Houses Conservatories Orchid Houses Fern Houses	60 to 65
Peach House Vinery Early Tomatoes and Cucumbers Tropical Palm House	65 to 70

Private greenhouses and medium size commercial greenhouses are mostly heated by hot water, and the large commercial houses by steam.

The radiation is made up of coils of pipe placed along the outside walls and under the benches.

Greenhouse Heating (continued)

Twenty or twenty-five years ago, it was customary to use 3 or 3½ in. pipe for the hot-water heating coils as the large water content of this size pipe maintained a steady temperature in the houses where there was no night fireman and the gardener gave no attention to the fire during the night.

Now, in most commercial houses where hot-water heat is used, the heating coils consist of 2 in. wrought iron or steel pipe. This smaller size, holding much less water per square foot of radiation than the larger sizes, enables the fireman to raise the temperature of the house much quicker than when larger size pipe is used; and when the sun shines the house can be cooled off much quicker—which is often desirable.

For small houses and long firing periods 3 in. pipe is best. In proportioning the amount of hot-water radiation required for a greenhouse, it is almost impossible to figure the air leakage through the laps of the glass. This is not of any importance, however, for in cold weather these laps freeze and seal tight. Those that have had years of experience and specialize in greenhouse heating consider the exposed glass surface and its equivalent only and can guarantee a specified temperature by dividing the exposed glass and its equivalent by the factors in Table B, which are based on the mean temperature of the water in the coils at 150 degrees and temperature outside at zero.

Greenhouse Heating (continued)

Greenhouses are generally partly glass, partly other materials. To simplify computation, the brick or concrete used is reduced to *equivalent* glass—i. e., a heat loss factor is applied to find the amount of glass which would have the same heat loss as does the building material used.

To reduce 9″ brick wall to equivalent glass, multiply number of square feet of wall surface by .8

To reduce 6″ concrete wall to equivalent glass, multiply number of square feet of wall surface by 1.3

To reduce 8″ concrete wall to equivalent glass, multiply number of square feet of wall surface by 1.14

To reduce 10″ concrete wall to equivalent glass, multiply number of square feet of wall surface by 1

(Heat loss through 1 sq. ft. of 10″ concrete wall is same as heat loss through 1 sq. ft. of double thick glass).

To reduce a frame wall, sheeting and clapboards on studding, to equivalent glass, multiply number of square feet of wall surface by 1

Having found the equivalent glass surface of the masonry material add it to the actual glass surface as indicated in Table B.

Greenhouse heating frequently can not be as easily and accurately figured as heating for other structures. Two greenhouses covering the same amount of ground surface may be quite different in square feet of exposed surface. The workmanship, quality of glass, and exposure to pre-

Greenhouse Heating (continued)

vailing cold winds must be taken into consideration. The humid atmosphere of greenhouses—and for some purposes the atmosphere is much more humid than for others, as for instance, for rose growing—at some temperatures causes the laps to seal with condensation, thus checking, or stopping the air loss through the laps. At lower temperatures, these laps are sealed with ice and at still lower temperatures, the inside surface of the glass is entirely frosted over so that its conductivity is changed. It may be much more difficult to heat a greenhouse at 15 to 25 degrees above zero with the wind blowing, than at zero or below, because at the low temperature the house may be sealed with ice, as stated.

Table B. Factors for estimating Hot Water Radiation for Greenhouses to obtain square feet of hot water pipe surface required*

For	70	to	75	deg. divide square feet of glass and equivalent	by 2.00
"	65	"	70	" " " " " " " "	" 2.28
"	60	"	65	" " " " " " " "	" 2.62
"	55	"	60	" " " " " " " "	" 3.00
"	50	"	55	" " " " " " " "	" 3.46
"	45	"	50	" " " " " " " "	" 4.00
"	40	"	45	" " " " " " " "	" 4.67
"	35	"	40	" " " " " " " "	" 5.50

*Based on average water temperature of 150°, a flow main temperature of 180°, and a 0° outside temperature.

Table B gives the factors for dividing the square feet of glass and equivalent in order to determine the square feet of hot water pipe surface. (See table Page 361 for square feet of surface in various pipe sizes). Table B factors are based on average water temperature of 150°F., a temperature in flow mains of 180°F. and outside temperature of 0°F.

Greenhouse Heating (continued)

Table C. Factors to Multiply Figures Obtained from Table B to Determine Square Feet of Hot Water Radiation for Other Than 0° outside temperature.

Outside Temperatures

5 deg. above 0	0.92
10 " " 0	0.84
15 " " 0	0.75
20 " " 0	0.66
25 " " 0	0.58
30 " " 0	0.50
5 deg. below 0	1.06
10 " " 0	1.15
15 " " 0	1.24
20 " " 0	1.33
25 " " 0	1.42
30 " " 0	1.50
35 " " 0	1.58
40 " " 0	1.63

Tables A and B are based on the house being of ordinary sound construction and tightly glazed with double thick glass.

Position of Radiation

Greenhouses are piped in all sorts of ways to suit the great number of different ideas of greenhouse owners and operators; the location and arrangement of the piping are governed largely by the plant bench or plant bed arrangement, suiting the special requirements of the plants or flowers to be grown in the houses. In houses for vegetable growing, where planting is directly on the floor of the green house, piping should be mainly, and if possible, entirely, on the sides so as to provide the maximum growing surface. For rose growing the piping should be more scattered or distributed than for any other purpose— if there are raised benches, some heating surface must be under every bench; if there are solid beds, some radiating surface must be in every walk.

The bulk of the piping for all purposes, however, should be on the side walls, or just inside the outer walls of the greenhouse. For sweet pea growing, most of the pipe surface should be on the side walls and some on the pipe columns, generally high enough to permit walking under. There is much latitude, however, in the placing of pipe coils.

Air Circulation

Recent experience shows that proper air circulation and conditioning greatly accelerates the growth of most plants and also prevents the growth of spores and moulds. This is accomplished by the use of proper mechanical apparatus for supplying and exhausting the air and for controlling its temperature and humidity.

(Compiled from the American Society of Heating and Ventilating Engineers Guide).

Chart No. 19 Sizes of Heating Fuels

The following chart shows the standard screen round mesh (in inches) used in sizing various fuels.

Name	Will Pass Thru	Will Not Pass Thru
Anthracite		
Broken or Grate	4 7/16"	3 7/16"
Egg*	3 7/16"	2 1/2"
Stove	2 1/2"	1 9/16"
Chestnut	1 9/16"	11/16"
Pea	11/16"	1/2"
No. 1 Buckwheat	5/8"	3/8"
No. 2 Buckwheat	3/8"	3/16"
No. 3 Buckwheat	3/16"	3/32"
Culm—residue from screening.		
*This is classed as "Egg" in the East. In Chicago the classifications for Egg are		
Large Egg	4"	2 3/4"
Small Egg	2 3/4"	2"
Domestic By-Product Coke		
Egg	3"	2 1/2"
Large Stove	2 1/2"	2"
Small Stove	2"	1 1/2"
Nut	1 1/2"	3/4"
Pea	3/4"	1/2"
Bituminous Coal		
"Lump" or "Block"		6"
Egg	6"	3"
No. 1 Roller Screened Nut	3 1/2"	2"
No. 2 Roller Screened Nut	2"	1 1/2"
No. 3 Roller Screened Nut	1 1/2"	1"
No. 1 Washed Egg	3"	2"
No. 2 Washed Stove	2"	1 1/4"
No. 3 Washed Chestnut	1 1/4"	3/4"
No. 4 Washed	3/4"	1/4"
No. 1 Domestic Nut	3"	1 1/2" or 2"
No. 2 Nut	2"	1 1/4"
No. 3 Nut	1 1/4"	3/4"
Duff	1/8"	

"Run of Mine"—fine and large lumps. "Screenings"—usually smallest sizes. "Pocahontas Smokeless"—generally sized as nut, egg, lump, and mine run. "Cannel Coal"—for fire places. "Hand picked lump;" for stoves, "egg".

Weights of Various Fuels

The weight per cubic foot of various fuels is as follows:

Anthracite	52.5	lbs.
Bituminous	45	"
Coke	28	"

The above weights can be used in determining the size of fuel bin required to store a pre-determined quantity. For example: If a heating system requires 20 tons of coal per season and it is desired to provide a fuel bin for the entire season's requirements, the cubical storage space can be computed as follows:

Divide the 40,000 lbs. (20 tons) by 52.5 pounds (the weight of 1 cu. ft. of anthracite) = 76.1 cu. ft. of space.

Firing Various Types of Fuel

Anthracite. Best results are obtained from anthracite when a deep bed of fuel is maintained at all times, even in mild weather. Infrequent, heavy fuel charges is the best and easiest method to follow. In mild weather, ashes should be allowed to accumulate on the grate to reduce the amount of air passing through the fuel bed and to assist in maintaining the temperature in the fire

Firing Various Fuels (continued)

box required for combustion. An anthracite fire should never be disturbed from the top because this interferes with combustion, causes draft holes and clinkers and tends to bring the ash to the surface of the fuel bed. Grates should be shaken with short, quick strokes which will sift the ashes through the grates without undue loss of fuel. The fire should not be checked by opening the fire door, because this chills the gases and interferes with combustion.

Grate Size Anthracite—on account of the size of the lump—can not be burned successfully in house heating boilers because of large air spaces between the lumps. In an emergency, however, it can be utilized when mixed with pea coal or buckwheat. These smaller sizes of coal fill the spaces between the lumps, thus forming a mass of burning fuel and preventing excessive air passage through the fuel bed. Grate size anthracite can be used in boilers with large fire boxes alone or mixed with smaller sizes.

Egg Size Anthracite should only be used in large fire pots, 25″ and over, and where a deep fuel bed can be maintained. Improved results can be obtained by mixing it with smaller sizes of anthracite, as explained in the preceding paragraph.

Firing Various Fuels (continued)

Stove Size Anthracite is the most popular size for domestic heating boilers. It is small enough to burn successfully in the smallest house heating boilers and large enough to permit carrying a deep fire without danger of the coal packing so closely that the air necessary for combustion is prevented from flowing through the fuel bed.

Chestnut Size Anthracite should be used in fire pots up to 20″ in diameter and particularly in boilers which have a shallow fire box.

Pea Size Anthracite is an economical fuel to burn as it is relatively low in price.

A grate with fine mesh should be used in boilers to prevent loss of fuel through the grate. If regular grates with coarse mesh are used, care must be exercised in shaking the grates; otherwise, there will be an undue loss of fuel through the mesh. In starting a new fire on coarse grates, it will be found advantageous to mix chestnut or stove size anthracite with the pea coal until sufficient ash has been accumulated on the grates to hold the pea coal in the fire box.

A fire box should be only partially filled with pea coal; otherwise insufficient air will pass through the fuel bed,

Firing Various Fuels (continued)

due to the compactness of this type of fuel. Pea coal requires a stronger chimney draft than larger sizes.

Buckwheat Size Anthracite requires the same attention as pea coal and is not recommended, excepting where fine mesh grates are used and a strong chimney draft exists.

A small blower to provide an induced draft will be found advantageous in connection with the use of buckwheat size coal.

Coke—Coke is fast becoming popular as a domestic fuel. It burns rapidly and requires less draft than anthracite. In order to control the burning of coke, it is important that all openings or leaks in the ash pit should be tightly closed. A deep bed of coke should be maintained at all times and a boiler with a deep fire bed should be selected when coke is to be used as fuel.

Grates should be shaken with short, sharp strokes and in mild weather a bed of ashes should be allowed to remain on the grates to assist in checking the fire. The best size of coke for house heating boilers is the size which will pass over a 1-inch screen and through a 1½-inch screen.

Firing Various Fuels (continued)

Bituminous Coal—Bituminous coal should never be fired over the entire fuel bed at one time. A portion of freely-burning coal should be left exposed to ignite the gases distilled from the new fuel charges. Air should be admitted over the fire through a special secondary air device or slide door. Before firing a new charge, the burning coal should be pushed back, leaving a depression in the fire box to receive the new charge. The fuel bed of burning coal should be carried as deep as possible, in order to have as much coked fuel as possible. A deep fuel bed obtains the longest firing intervals. The boiler output obtained when burning bituminous coal will generally exceed the output of a boiler where anthracite coal is used. Bituminous coal, however, requires frequent attention because of its free and rapid burning qualities.

Proportions of average Fuel Consumption by Months — Vicinity of New York

Calculations over a period of 33 years

October	7.98	per cent of fuel
November	12.96	" " " "
December	17.07	" " " "
January	19.01	" " " "
February	18.18	" " " "
March	14.87	" " " "
April	9.93	" " " "
TOTAL	100.00	per cent

Pipe Welding

THE welding of steam pipes is rapidly coming into general practise. It lowers the cost of installation where large pipes are required and materially reduces the weight.

Welding is practicable and economical for all sizes of pipes 2″ and larger. The facility with which both regular and unusual fittings may be welded from pieces or ends of straight pipe is particularly advantageous both from the viewpoints of appearance and economy. The saving of time lost in waiting for deliveries of special fittings is also a factor in favor of the welding process.

Welding requires an experienced and skilled mechanic, since the welded joint must become homogeneous with the metal of the adjacent pipes. Welded joints properly made are stronger than pipe of corresponding size and possess greater strength than cast iron fittings.

The equipment required is inexpensive and consists merely of the torch with suitable welding and cutting tips of assorted sizes, with gas regulators and gauges for tank connections and suitable lengths of pressure hose. A two-wheel truck to hold the gas tanks is also desirable.

Welding is facilitated by the use of pattern charts obtainable from one of the principal sources of oxygen and acetylene gas supply.

Directions for Cleaning Boilers

THE boiler and system must be cleansed, as grease, oil and foreign matter prevents steaming, and causes foaming and an unsteady water line. Each National boiler is provided with a tapping for skimming oil and grease from the surface of the water; this tapping is termed the "skimmer tapping". In sectional boilers (excepting Low Water Line Series) it is located in the front section in a line with the upper nipple ports. The "skimmer tapping" is located in the end section of Low Water Line Boilers in a line with the upper nipples. In round boilers it is located in the steam dome section near the water line. By removing the plug from the skimmer tapping and attaching a nipple and a gate valve thereto the boiler can be thoroughly boiled out and all grease and oil skimmed from the surface of the water.

To do this shut off the valve (if there is one) connecting the return main to the boiler and maintain the water in the boiler at boiling temperature and at the level of the skimmer tapping. As the water boils out through this opening replace it with fresh water, always maintaining the water level up to the skimmer tapping. Continue this operation until the water emitted from the skimmer tapping runs clean and clear. (This may require a number of hours or even an entire day.) Then close the valve on the connection to skimmer tapping and the valves on the steam main or the supply valve on every radiator if the mains are not valved. Raise the pressure in the boiler to about 10 lbs. and blow the boil-

Cleaning Boilers (continued)

er down completely through the blow-off connection at the bottom and rear of the boiler. Dump the fire immediately and allow the boiler to cool. This operation should clear the boiler of all solid matter.

It is also necessary to thoroughly cleanse the entire heating system of grease, filings, and foreign matter. This is accomplished by refilling the boiler, after it has cooled, with clean fresh water and raising several pounds of steam pressure. Circulate steam through the entire system under boiler pressure and dump the returns into the sewer without allowing them to come back into the boiler. For this purpose a tee should be placed in the return line to boiler ahead of a cut-off valve so that the returns may be dumped into the sewer without entering the boiler. During this operation feed fresh water constantly into the boiler so that an even water line is maintained. Continue the operation until the returns from the system which are dumped into the sewer run clean and clear. Foreign matter in the heating system will accumulate in the boiler if the system is not cleaned out.

The above cleaning operations are absolutely necessary in order to obtain satisfactory results and should be repeated from time to time until both the boiler and the heating system are thoroughly cleaned and free from all trace of grease, oil and foreign matter.

The importance of properly and thoroughly cleaning steam and vapor systems of oil and grease can not be emphasized too strongly.

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